



ANNUAL REPORT

Academic Year
2022 - 2023

International Space University

In 2022, International Space University celebrated its **35th anniversary**. Fast forward to the present, ISU now boasts an impressive legacy, with 5600 alumni influencing the global space ecosystem across 112 countries. ISU provides a wealth of dynamic programs for international postgraduate students and professionals.

These programs include the Master's degree Program in Space Studies, the Space Studies Program, the Southern Hemisphere Space Studies Program, and Executive Space Courses, designed to prepare and retrain the future space workforce. ISU also encourages entrepreneurship and provides support for startups through its dedicated in-house Incubator, thus expediting the link between space and business.

The attainment of **the accreditation for the ISU Master's Program** by the Accreditation Agency for Study Programs in Engineering, Informatics, Natural Sciences and Mathematics (ASIIN) marked a crucial milestone in enhancing the recognition of the International Space University (ISU). From the academic year 2023/2024 forward, the ISU will unveil a thoroughly revised and updated curriculum for its Master's degree program. This revamped course of study has been designed to keep pace with the evolving landscape of space operations, space industry, and scientific endeavors.

The space sector is increasingly merging with global economic sectors. Understanding space is essential for enhancing our knowledge of planet Earth, battling the consequences of climate change, and contributing to the global socio-economic development in the coming years. The evolving space economy, which includes new and emerging space nations, is fostering a vibrant commercial and public space sector teeming with entrepreneurial leadership and private investment, and offering promising prospects for ISU students and professionals.

Below is a summary of programs, activities, and achievements of the International Space University in the academic year 2022/2023.

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Introduction

Welcome to the Annual Report of the International Space University (ISU) for **the academic year 2022/2023**. As we reflect upon the past year, we proudly showcase the numerous achievements that are a testament to our dedication to interdisciplinary, international and intercultural space education. Despite the global challenges, ISU has proven its resilience, adaptability, and commitment to training the next generation of space pioneers. This year, our mission to inspire, innovate, and invigorate has been strengthened by the accreditation of ISU's new Master of Science program in Space Studies that will commence in September 2023.

September kicked off ISU's academic year introducing the Master of Space Studies MSS23 class to the ISU staff and faculty, and to local authorities and various partners of ISU. Many ISU faculty and staff members, as well as alumni, attended the very successful International Astronautical Congress (IAC22) in Paris. ISU organized the IAC22 Science and Academic Day breakfast entitled "Developing Success from Failures", moderated by Deganit Paikowsky. The traditional IAC Space Generation Advisory Council (SGAC)/ISU/International Astronautical Federation Young Professionals committee networking event allowed 600 people to exchange contacts, information, and ideas. The ISU President and many ISU global faculty members participated in sessions of the UN General Assembly Science Summit, on 26 September 2022. Dr. Ken Davidian joined the ISU Team as the new Vice President for North America and James Lewis as the new SSP Director from NASA Johnson Space Center JSC.

October saw an online "Discover ISU" event focusing for the first time on the Asia-Pacific region and allowing prospective students from that area and beyond to learn about ISU's educational programs.

November was an intense month during which significant progress was made on the building refurbishments at the Central Campus in Strasbourg. It also saw the return of the ISU experiment Hydra 3 from the International Space Station, which was safely handed over to ESA UK. Two very successful Executive Space Courses were held in Tel Aviv, Israel and Seoul, South Korea, with 28 and 25 participants, respectively.

ISU was invited to co-sign the "Statement for a Responsible Space Sector" in Paris and hosted the French version of the 4th edition of the CASSINI Hackathon. The ISU team "SUNER-G" was selected by the jury to represent France among the nine other European countries in the competition. SUNER-G won and is now part of the 10 best teams of the edition "Space for the Financial World 2022"!

December – an ISU delegation including the ISU President, faculty, and the ISU Incubator personnel attended the New Space Economy Expoforum event in Rome. The ISU President gave a presentation during the Opening Ceremony and the ISU Incubator delegation led several workshops. ISU was also an active participant in the exhibition of the congress.



January was the starting month for the Southern Hemisphere Space Studies Program, which was held for the first time after the pandemic as an in-person event with 38 participants in Adelaide, South Australia, in partnership with UniSA (the University of South Australia).

February included several significant events:

- 60th Session of the Scientific and Technical Subcommittee of UN COPOUS
- 50th Assembly of ISU's Academic Council
- Board of Trustees meeting #70
- ISU Adelaide Space Conference. This year's Space Agency Panel discussed "The role of space agencies in commercial space", moderated by the ISU President.

March - Sláinte from the European Astronaut Center in Cologne, Germany!

ISU MSS23 students were learning all about astronaut fitness and egress training, how to operate European hardware onboard the ISS, providing medical care to astronauts, communicating with the astronauts, public relation training, and visiting facilities like the astronaut training center, neutral buoyancy pool and the EUROCOM room. Thank you to our hosts, including ISU MSS alumni Giorgio Lorini and Marco Marsh! Celebrating the International Women's Day 2023, Dr. Bertrand Goldman organized, a panel for the Master of Space Studies MSS23 class about diversity and inclusion. Panelists included the ISU Chancellor, the ISU President, and many high-level expert speakers.

April - ISU is revolutionizing space education, and, on its 36th anniversary (12 April 2023), announced a revised and updated Master of Science (MSc) in Space Studies, which has been accredited by the Accreditation Agency for Study Programmes in Engineering, Informatics, Natural Sciences and Mathematics (ASIIN e.V.).

An ISU delegation including the President, Vice President, Prof. Nicolas Peter, and ISU Admission staff participated at the Space Symposium in Colorado Springs, USA, and contributed to the International Space Cooperation Luncheon, the International Education Panel, and the Exhibition. In April 2023, ISU applied for candidacy status with the US Accreditation Council for Space Education (ACSE) for the Master's degree program: Space Studies.

April was the month in which the MSS23 program ran four elective courses on the important topics of NewSpace, Space Sustainability, Astrobiology, and OMICS and Human Space Performance, which also attracted a few external participants.

May marked the 70th anniversary of the European Parliament. An historic and vibrant gathering – organized by the European Collectivity of Alsace and supported by the European Space Agency and International Space University's Prof. Nicolas Peter. The event took place on Tuesday 30th May 2023 at the European Parliament in Strasbourg, France, where more than 1000 young singers from the 27 European countries celebrated.

A photograph of the European Union flag, featuring a blue field with twelve gold stars arranged in a circle. The flag is waving on a flagpole. In the foreground, there is a white rounded rectangular box containing the text "European Flag".

European Flag

June launched the 35th edition of the Space Studies Program (SSP) in Sao Jose dos Campos, Brazil. To address the request for digital education, ISU organized a four-week online program that ran in parallel to the core lectures of SSP23.

In June the ISU Incubator officially became a member of the French Tech Est network. The French Tech initiative aims to set up programs to help the development of start-ups in France and to federate an ecosystem that brings together start-ups, investors, political decision-makers, and community builders like ISU.

July - The International Space University's (ISU) annual Alumni conference was organized from 27 to 29 July 2023. ISU Alumni came from all over the world to join the SSP23 staff, lecturers, and participants in Sao José dos Campos, Brazil. They assembled for an unforgettable reunion and celebration of ISU's 35th Space Studies Program, coordinated by SSP22 alumnus Erik Busnello Imbuzeiro.

August included the presentations of four Space Studies Program Team Projects and the conclusion of the 35th Space Studies Program in Brazil. ISU also started to compile a five-year plan to design new programs, develop digital education, and shape the future of ISU. During August, preparations for new programs like the Space Sector Crash Course were fully underway.

Visit in the European Parliament with Nicolas Peter.



1. Summary and Key Figures

1.1 Summary and Key Figures

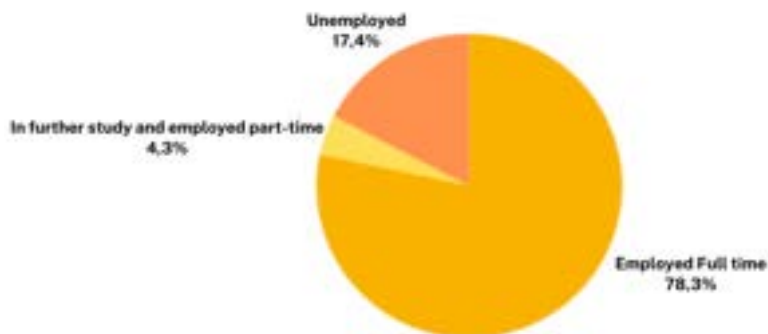
Program	Location	# Participants
Executive Space Course 1 – Tel Aviv	Tel Aviv, Israel	28
Executive Space Course 2 – South Korea	Seoul, South Korea	25
Executive Space Course 3 – Strasbourg	ISU Central Campus, France	42
Space Ressources Professional Course	Luxemboug City, Luxembourg	32
Master of Space Studies 2023	ISU Central Campus, France	37
Space Studies Program (SSP23)	San José Dos Campos, Brazil	92
Southern Hemisphere Space Studies Program (SHSSP23)	Adelaide, Australia	38

1.2 MSS22 Alumni Employment Statistics

In June 2023, 23 alumni answered the survey.

78,3% of the MSS22 alumni who answered reported having a job. Moreover, **4,3%** of them said that they are continuing their studies while having a part-time job; finally, 17,4% mentioned being in another situation (such as working on a personal project, developing their own business, or looking for employment).

Employment statistics



1.3 Faculty

During the academic year 2022/2023, ISU counted:

- **77 Full Faculty** (see list in Annex 1)
- **50 Adjunct Faculty** (see list in Annex 1)
- **16 Associate Faculty** (see list in Annex 1)

1.4 Alumni

After SSP23 and MSS23 graduation, ISU now has **more than 5600 alumni** from 112 countries (see chapter 9 Alumni Affairs for more details).

2. Master of Science (MSc): Space Studies

The accreditation for the Master's Program by the **Accreditation Agency for Study Programmes in Engineering, Informatics, Natural Sciences and Mathematics (ASIIN)** marked a crucial milestone in enhancing the recognition of the International Space University (ISU). Under the vigilant oversight of the Dean, Resident Faculty, Academic Council, ISU Alumni and external experts, a significant overhaul of ISU's Master's program was executed.

The revised Master's Program, which is now divided into **three semesters** extending over 18 months, has been designed to offer numerous academic trajectories. These varying pathways will cater to the students' diverse educational backgrounds and prior knowledge, ensuring a more individualized and comprehensive learning journey.

ISU is introducing this new accredited Master of Science (MSc) in Space Studies in the academic year 2023/2024. The program aligns with Level 7 of the European Qualifications Framework for Life-long Learning (EQF LLL).

The curriculum is designed to equip graduates with essential knowledge at the nexus of all space disciplines, thereby enabling them to deconstruct and analyze multi-dimensional problems. Given the increasing influence of the NewSpace sector, the program places significant emphasis on entrepreneurial aspects within the space sector. This includes covering the inception of, and funding for space start-ups, and a robust understanding of space project management techniques.

The program fosters a hands-on learning environment, with group assignments, teamwork, and a comprehensive Team Project. These collaborative experiences equip graduates to utilize knowledge from disparate fields to tackle a broad spectrum of projects and challenges within the space sector. Graduates can thrive within international and interdisciplinary environments.



3. Master of Space Studies – MSS23

3.1 Summary and Key Figures

The MSS23 class was the first class not severely affected by the coronavirus pandemic and attended predominantly in-person classes and many professional visits. There was still additional workload for the MSS team to manage multiple student cohorts simultaneously while preparing for a new accredited Master’s program. MSS23 included **seven students from 18 countries**. The MSS23 cohort is scheduled to celebrate their graduation ceremony in person on 15th December 2023, when all students finish their prolonged six-month internships.

3.2 MSS23 Cohort



Fig 1: MSS23 class picture

The Master of Space Studies (MSS) program 2023 (MSS23), counted 37 students from 18 countries.

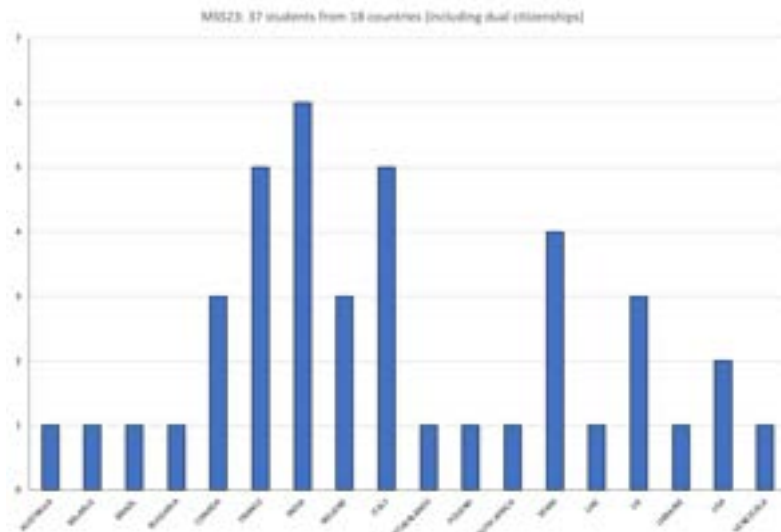


Fig 2: Distribution of MSS23 participants per country including dual citizenships

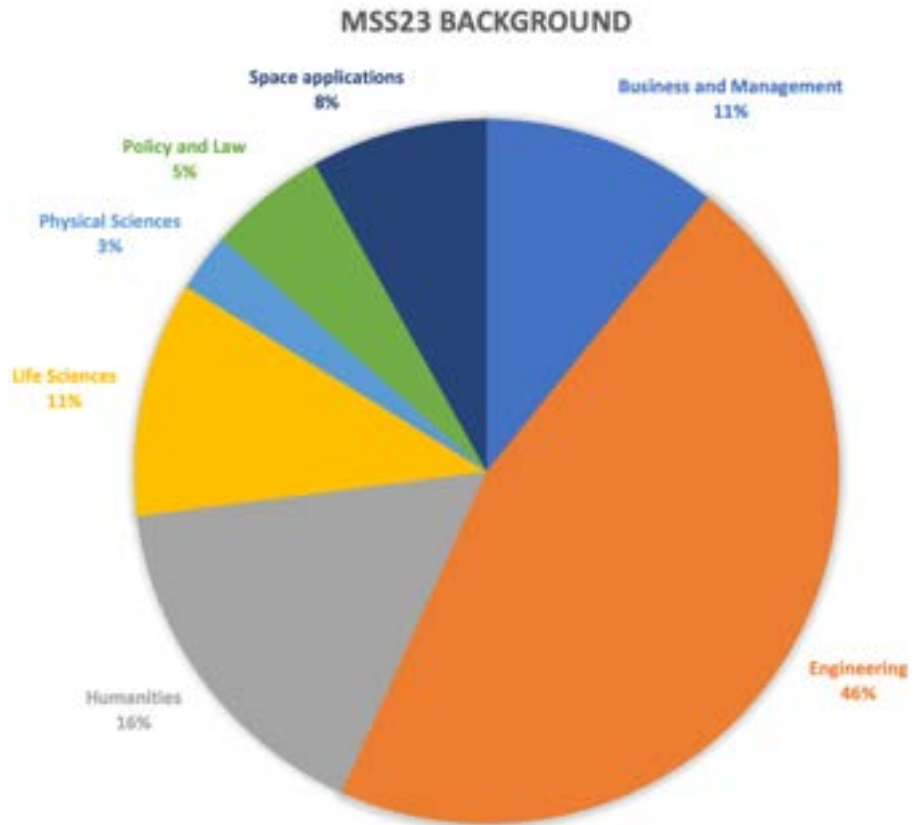


Fig 3: Educational background of MSS23 participants

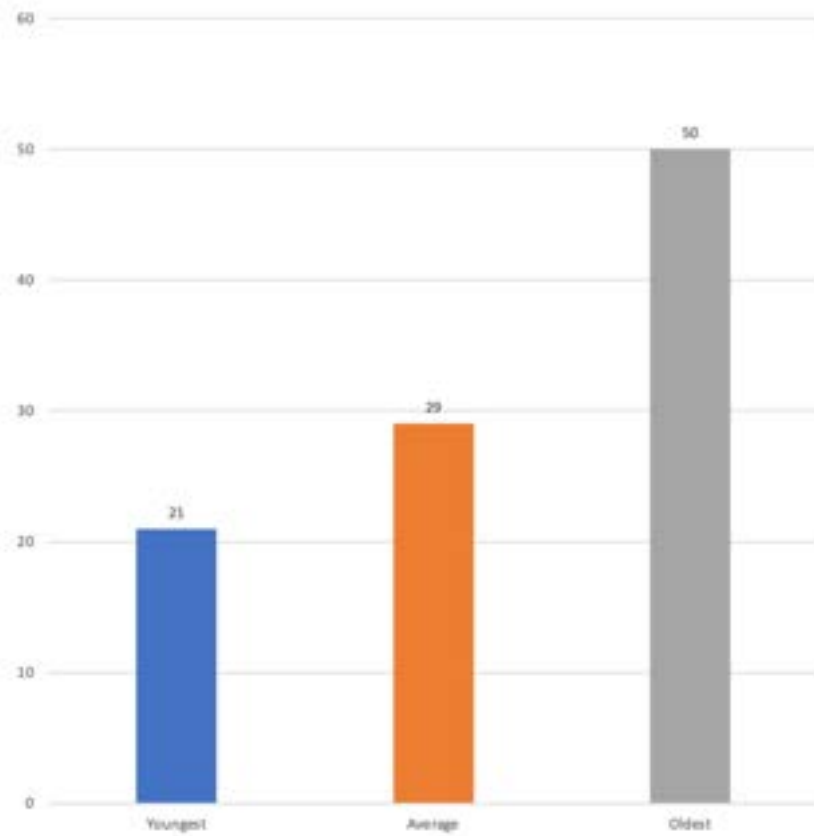


Fig 4: Age Distribution of MSS23 participants

MSS23 EXPERIENCE

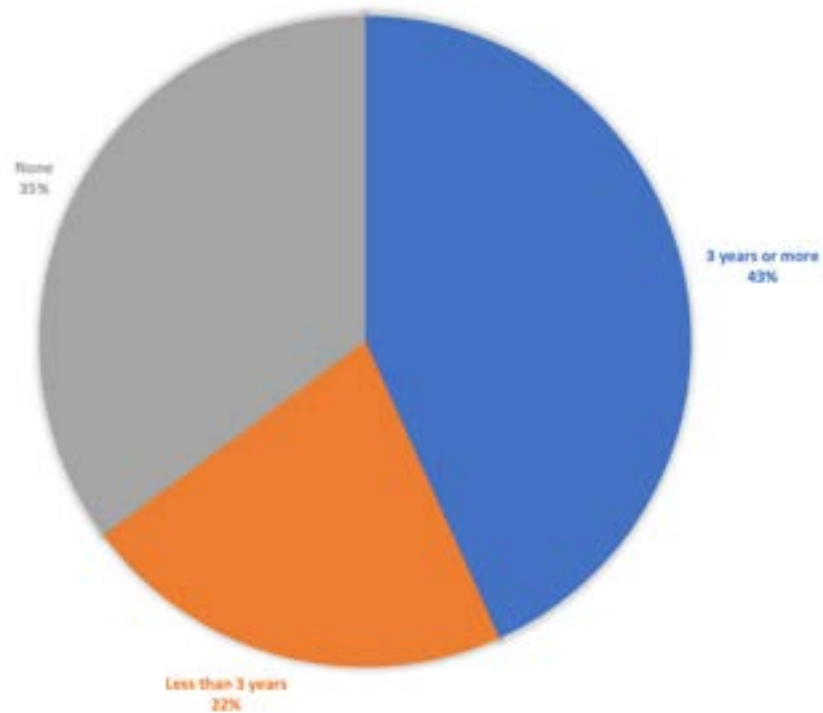
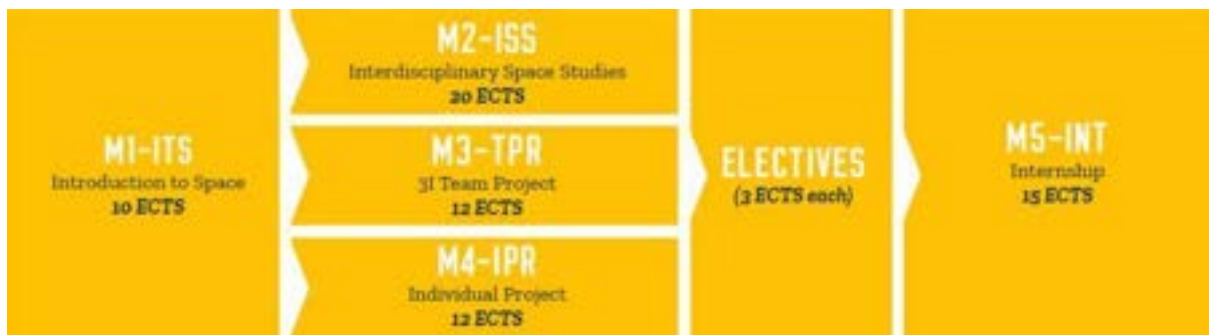


Fig 5: Distribution of previous experience in MSS23

3.3 MSS23 Structure

The following scheme depicts the MSS generic structure:



The choice of MSS two-week-long electives included:

- M10-ABL Astrobiology
- M13-NSE New Space and Entrepreneurship
- M14- Space and Sustainability
- M7-HPS Space Omics

3.4 MSS23 Activities

The following professional visits were organized:

- Satellite Communications Provider SES professional visit in Luxembourg
- Aerial -local in Strasbourg
- Research Institute Against Digestive Cancer IRCAD – local professional visit to the state-of-the-arts medical robotics enterprise located in Strasbourg
- Max Planck Institute of Astronomy and Astrophysics in Heidelberg, Germany
- Ries Crater Field trip in Nördlingen, Germany
- European Astronaut Centre Professional Trip in Cologne, Germany

At the very beginning of February, the MSS23 cohort was traveling to the Max Planck Institute of Astronomy in Heidelberg, Germany. The cohort was accompanied by Dr. Prof. Goldman, representing ISU resident faculty, Dr. Renate Hubele, and Dr. Markus Nielbock from the Max Planck Institute. The students visited numerous scientific and research facilities, such as the Origin of Life Laboratory and the Infrared Space Laboratory. A planetarium shows and presentation of a 3D model of the Solar neighborhood were the last items on the agenda.

As a consequence of this visit, some students confirmed their internship arrangements at the Institute and the Haus der Astronomie, located on the same campus.

After a long, five-year break, MSS students returned to the European Astronaut Training Centre. The cohort was greeted by EAC officials including André Rosenberger (Countermeasure Exercise Team Lead), and ISU alumni, working on the spot. With a great deal of enthusiasm and motivation, the students and numerous ISU staff members toured the EAC Training Hall, Neutral Buoyancy Facility, and the EUROCOM control room. The final photo taken on the premises ended the official part of the visit.



Fig 6: MSS Students at the European Astronaut Training Center

As in every year, the MSS class took part in a field trip to the Ries impact crater located in Nördlingen in Bavaria. Prof. Stefan Hölzl, Director of the Ries Krater Museum and Professor at the Ludwig Maximilian University of Munich, organized a tour of the interesting outdoor sites and guided participants through the museum.

Other MSS23 activities included:

- Rocket Launch Competition
- Poster competition
- Team building sessions within the class cohort and both Team projects
- Space Architecture and Design Zero Gravity Workshops
- Human Performance in Space workshops
- Lunar Lander Workshops
- Robotics Workshops
- Satellite Ground Station Workshop

In early September, ISU organized the MSS Rocket Launch Competition. The monumental event honors our legendary colleague, Professor Nikolai Tolyarenko (1941-2015). Six MSS 2023 teams in consultation with MSS 2015 alumnus, Dr. Adrian Eilingsfeld, designed, constructed, and launched miniature rockets with almost impossible guidelines: Each rocket must have a quail's egg onboard, which must be returned unbroken. Each team must return working accelerometers and video cameras. Finally, each rocket could not exceed an altitude of 100 meters. Despite these impossible constraints, our students rose to the challenge and all rockets were successfully launched.

3.5 MSS23 Individual Projects

This year, two prizes were allocated: the Manx Precision Optics Prize – sponsored by Helmut Kessler, and awarded to Tomasz Adach for achieving the highest grade in his Individual Project; and the Association of Space Explorers Europe Prize, presented to MSS23 Carla Tamai for her outstanding Individual Project focused on Human Space Flight.

3.6 MSS23 Team Projects

TP: Feasibility study for a Commercial Space Station in Low Earth Orbit

This Commercial Space Station team was charged with planning a financially independent space station for use in low Earth orbit – a business park in space that would be a significant departure from previous space missions reliant on government support. The group chose to focus initially on Technology Readiness Level 7 activities feasible within this decade, then followed with an extrapolation for the next 20 years. The team focused on the potential uses of an orbital business park and identified some untapped markets in the creative arts. The team will present at the upcoming IAC meeting and is currently preparing their conference paper. This Commercial Space Station team was led by the Faculty Interfaces Drs. Virginia Wotring, Taiwo Tejumola, and Gongling Sun.



Fig 7: TP Cover page MSS23

TP: Venus

Venus is our nearest planetary neighbor and its evolution from ancient times to the present day has often been contrasted and compared to Earth. For example: What can the Venusian runaway greenhouse effect tell us about our own, both contemporary and future? Despite such scientific potential, interest in our nearest neighbor has waned in recent decades. “TP Venus” attempted to rekindle this interest. They started off with the concepts and philosophies surrounding the hiatus in outreach about planet Venus. They addressed the importance of Venus as a prime exploration target. As the central thrust of the TP, the team proposed a tool for addressing ‘Venusian apathy’ via the creation of an original and timely board game targeted at the general public. For this concept, they presented a business plan for production and, ultimately, commercial reality. TP Venus examined future Venusian exploration missions from an interdisciplinary perspective, including all the major disciplines relevant to the ISU “3-Is” curriculum. The team will present their work and their product at the upcoming IAC meeting in an extended slot. This Venus team was led by the Faculty Interfaces, Prof. Hugh Hill, and Dr. Bertrand Goldman.

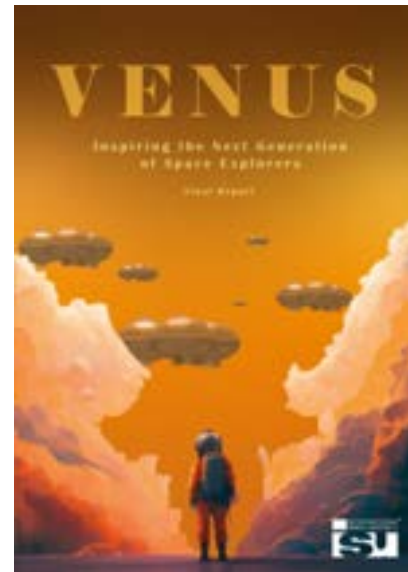


Fig 8: Cover Page of the final report



Fig 9: Illustration of the game board to be presented at the IAC74

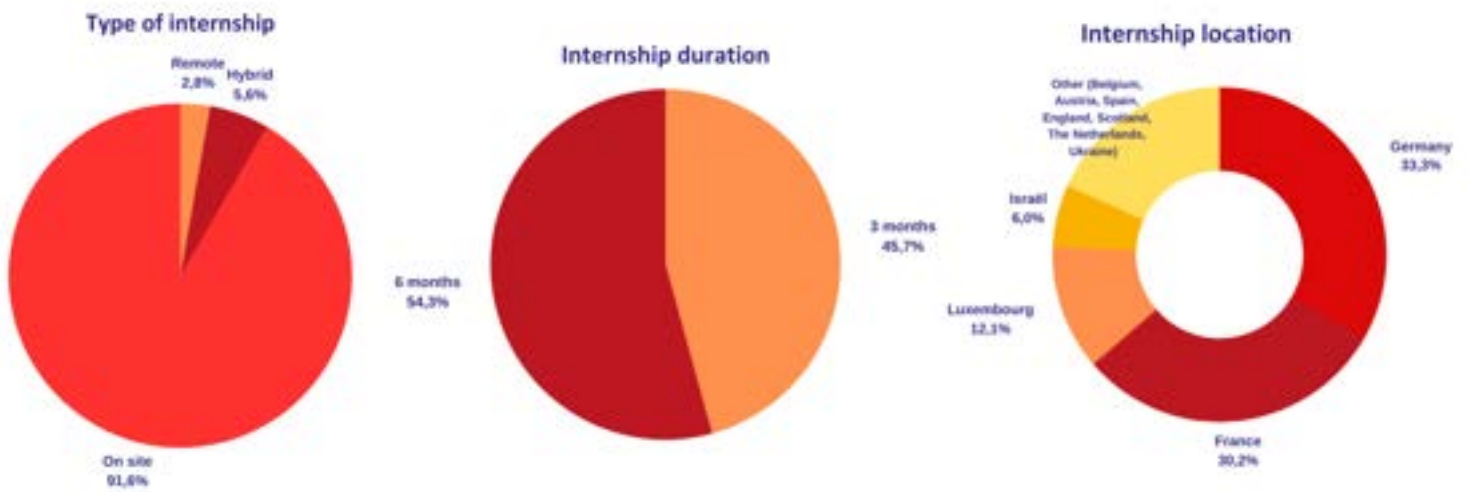
3.7 MSS23 Internship

As the new accredited program is around the corner, sending students from MSS23 to diverse internships was one of our priorities this year. Indeed, 100% of our students got an internship or a full-time position. The possibility of doing remote or hybrid-type internships was still available. However, most of our students took the opportunity of going on-site, to truly dive into the life of professionals from the space sector.

The number of students who carried out a short internship (18 students out of 36) was a little higher than expected. Nonetheless, some of the internships were extended to six months. The following graphics show the duration, location, and type of internship that the MSS23 students carried out.



Fig 10: Guilhem Le Carrour (MSS23), interning at Space Applications



4. Space Studies Program – SSP23

4.1 Introduction

The 35th Space Studies Program of the International Space University (SSP23) was hosted by the National Institute for Space Research (INPE - Instituto Nacional de Pesquisas Espaciais), the Aeronautics Institute of Technology (ITA - Instituto Tecnológico de Aeronáutica), with the support of the Municipality of São José dos Campos (Prefeitura de São José dos Campos), from Monday, 26 June 2023 to Friday, 25 August 2023. The SSP team is extremely grateful to our wonderful hosts, who continuously supported the SSP program and were available to accommodate all the program requests at their best.

The following details can provide some clarity on the planning and delivery of the program:

- SSP23 had a hybrid format, accommodating both onsite and online participants.
- While the onsite program was designed for nine weeks, the online part of the program took place from 26 June to 21 July 2023 with the online cohort attending and contributing only to the Core Lecture Series.
- SSP23 brought together 92 participants representing 26 nationalities, from which 85 participants were onsite, and seven participants were online. The participants represented a variety of backgrounds in science, engineering, humanities, and social sciences.
- For the onsite participants, the first six weeks of the nine-week program were held at ITA, while the last three weeks were held at INPE.
- The onsite SSP was divided into three phases: Phase I - Core Lectures; Phase II - Departmental Activities, and Phase III - Team Projects.
- There were 55 Core Lectures; 14 Departmental Sessions; and seven Team Project Sessions from Week 1 to Week 6. From Week 7 to Week 9, the program focused mainly on the Team Project working sessions and Team Project deliverables.
- The 55 Core Lectures were designed to provide all participants with an interdisciplinary, intercultural, and international perspective on space activities.
- The Final Presentations were successfully live streamed on YouTube on Thursday, 24 August 2023. The participants presented their findings in each of the four Team Projects to an international audience:
 - From Slums to Smart Cities, Bringing space-based technology to favelas in Latin America: Pathways to Smart and Inclusive Development
 - Space Situational Awareness, On-Orbit Collision Avoidance
 - SAFEWATERS: Space Applications for Emergencies, Water Assessment, Technological Enhancement, Response, and Water Security
 - The Role of the METAVERSE in the Future of the Space Sector

The content was delivered by over 130 instructors, the majority traveling onsite and representing the ISU Global Faculty, invited international experts, and local experts under the academic leadership of a team of 20 Chairs which included: two Core Lecture Chairs; ten Department Chairs; five Team Project Chairs and four Team Project Associate Chairs.

The SSP23 activities accommodated around 16 Professional Visit Hosts, who helped organize the professional visits to companies including EMBRAER, Centro Nacional de Monitoramento e Alertas de Desastres Naturais (CEMADEN), Parque Tecnológico São José dos Campos, Engenharia Aeroespacial (AKAER), Institute of Aeronautics and Space, Entrepreneurial Education Center (CEDEMP), and Brazilian Decimetric Array. To add to this number, there were about 51 people as part of the SSP team, including volunteers. Together with special guests and the Local Organizing Team members contributing directly, the SSP23 resulted in more than 330 individuals involved in total.

4.2 Participants

The following pictures represent highlights of some of the activities and the figures will provide more clarity on the overall distribution of the SSP23 participants.



Fig.11: Participants and the SSP team in front of the cable-stayed bridge in São José dos Campos, known as the Innovation Arch



Fig.12: SSP23 Participants taking a picture in front of the ISU themed bus, at INPE. The bus wrapping was organized by the LOC team and several buses like this one have been included in the public transportation system in São José dos Campos



Fig.13: The SSP23 patch designed and adopted by the SSP23 participants

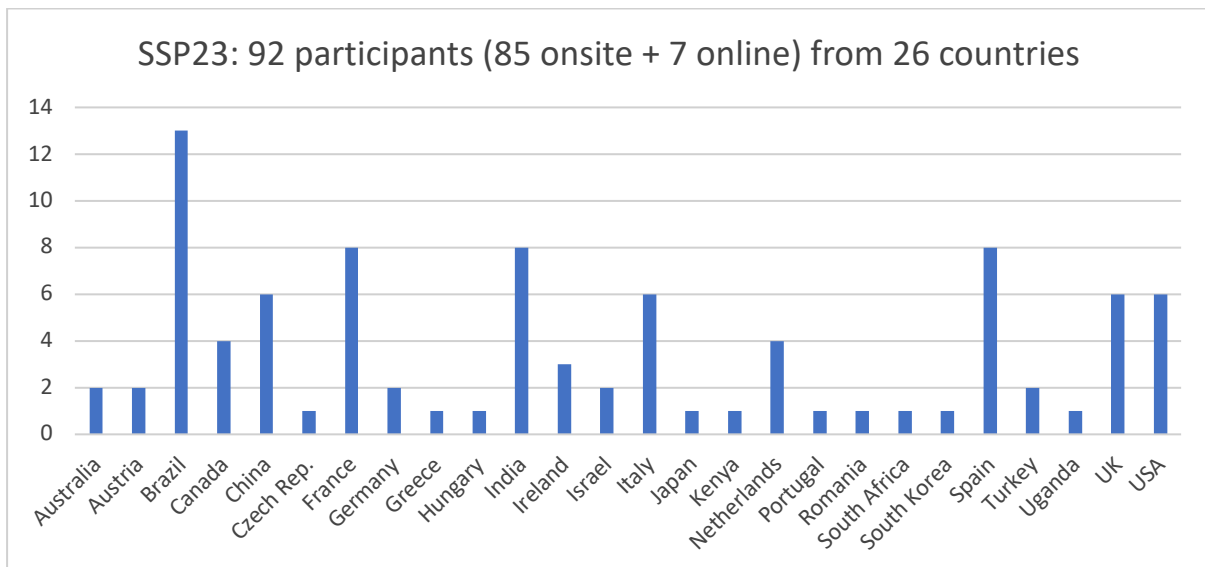


Fig.14 : Number of SSP23 participants by nationality

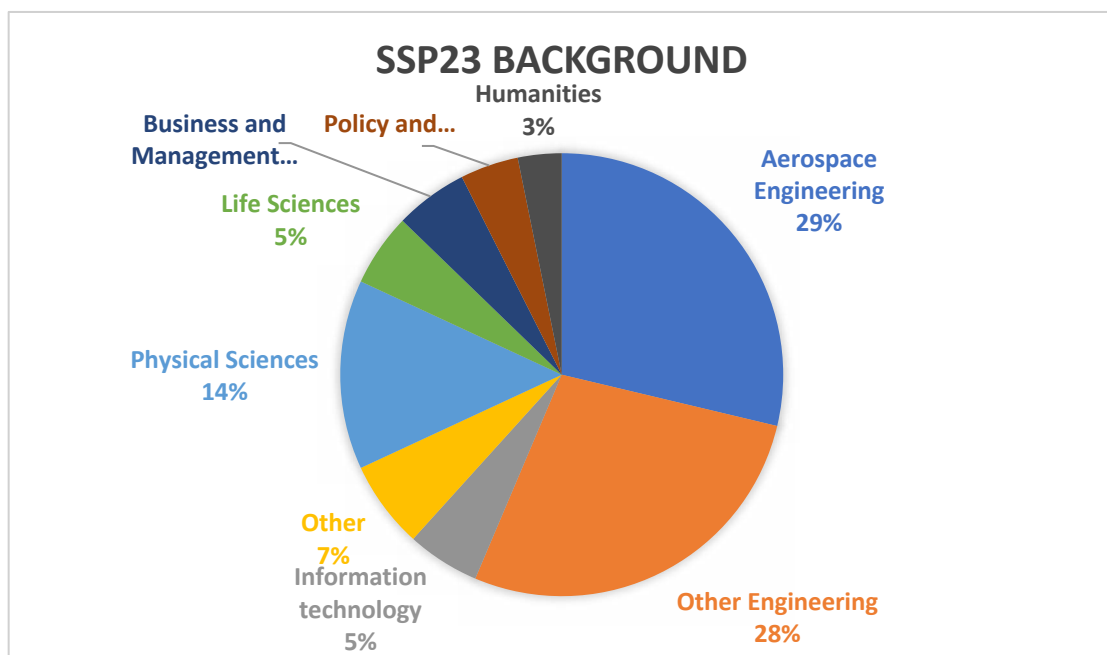


Fig.15: Educational background of the SSP23 participants



Fig.16: SSP23 participants' Professional experience

4.3 SSP23 Content

The SSP23 onsite curriculum offered the following components:

- 55 Core Lectures on all Space-related disciplines
- Over 30 hands-on workshops, including Elective Workshops, Fundamental Workshops and Theme Days
- 14 half-day sessions offered by each of the seven Departments: Space Sciences (SCI); Space Engineering (ENG); Human Performance in Space (HPS); Humanities (HUM); Space Management and Business (MGB); Policy, Economics and Law (PEL); and Satellite Applications (APP).
- Four Team Projects (presented in more detail in the next section)
- Professional visits to space-related research facilities and companies in Brazil, including indoor and outdoor activities in cities: Rio de Janeiro, Cachoeira Paulista - São Paulo, Santos and Campos do Jordão.
- Seven distinguished lectures, panels, and public events with prominent speakers from academia, government, and industry - including Astronauts
- One week-long Alumni Conference.

Including the Core Lecture Series, Workshops, Team Projects, Department Activities, and the Distinguished Lectures SSP23 offered 276 hours of Academic Teaching.

SSP23 was organized into three consecutive, 3-week interrelated phases: (i) Phase I – Core Lecture Series; (ii) Phase II – Departmental Focus and (iii) Phase III – Team Projects, for which each participant’s performance was assessed. You can see below the Program overview:

Phase I Core Lecture Series		Phase II Department Focus		Phase III Team Project	
Morning Core Lectures		EXAM	Department Activities, Workshops, Professional Visits	INDIVIDUAL PROJECT PRESENTATIONS	TEAM PROJECT PRESENTATIONS
Afternoons Department Introduction Workshops	Afternoons Department Activities, Workshops				
SSP Academic Program Overview					

Fig.17: SSP23 onsite Academic Program structure

The online participants attended and contributed to the 55 Core Lecture Series. The online participants joined the Core Lecture sessions daily by using a Zoom link and contributed by asking questions to the instructors.

4.4 SSP23 Team Projects

The SSP23 Team Projects tackled the following topics:

The Team Project *“From Slums to Smart Cities, bringing space-based technology to favelas in Latin America: Pathways to Smart and Inclusive Development”* was chaired by Remco Timmermans, and TP Associate Chair, Kleber Naccarato. With the concept of Smart Cities as a starting point, this TP explores the potential of space-based solutions to create intelligent, inclusive, and sustainable favelas. The TP Team focuses on favelas as they represent a central development challenge in Brazilian cities that can benefit from space-based solutions.

Through an extensive literature review and talks with various local experts in the state of São Paulo, the team delved into specific challenges currently faced by favelas, while also considering future directions.



The study includes in-situ data to grasp the structural nature of the favelas, while considering difficulties in urban planning, and environmental protection. Furthermore, a review of social resources and census data, or lack thereof, and security concerns were considered. This provides a multifaceted perspective on the living conditions within these areas and highlights some of the complex characteristics of favelas that impact the everyday life of residents.

Following an extensive analysis, the TP Team identified significant gaps that space-based technologies could help to fill, while highlighting opportunities where these could be effectively implemented. Using these insights, the team developed a roadmap, categorizing solutions into short-term, mid-term, and long-term strategies. This roadmap outlines a comprehensive plan that considers not only immediate necessities but also focuses on sustainable growth and community development for the future.

Implementation of these recommendations in emerging markets faces many challenges. The TP team discussed the ethical and privacy concerns since data would be collected, most likely, without consent. Stakeholder awareness, regulatory issues, infrastructure challenges and financial barriers are also addressed and a risk matrix is provided on how these challenges could impact the implementation of the recommendations.

The main goal of the research carried out was to provide recommendations to enhance the quality of life in favelas through the innovative use of space-based technologies. Combining an understanding of slums with innovative space technology enables a vision of smarter and more inclusive cities. Overall, this study is not limited to Brazilian favelas but provides solutions that can be applied to slums globally.

The Team Project ***“SAFEWATERS: Space Applications for Emergencies, Water Assessment, Technological Enhancement, Response, and Security”*** was chaired by François Spiero, with Lincoln Alves, as TP Associate Chair. According to the Team, water security is a pressing challenge worldwide, exacerbated by climate change impacts. In Brazil, natural disasters like droughts and floods threaten water security, disproportionately affecting disadvantaged communities. This TP report investigates Brazil's use of space capabilities for water security, focusing on disaster monitoring, preparedness, response, and recovery. Following an overview of relevant water security concepts and the status of water security in Brazil, this report examines the use of space applications across three specific water security domains. First, remote sensing technologies are examined to track environmental indicators related to droughts, floods, pollution and landslides for monitoring and preparedness. Second, the use of satellite communications, emergency mapping, and navigation satellites are examined for use during disaster response efforts to coordinate and guide relief work. Finally, the report proposes opportunities to strengthen policies, infrastructure, data capabilities and community outreach.



As a result of the work detailed in this report, the Team proposed seven key recommendations to the global space community and policy makers in Brazil:

- Integrate resilient water regulations with green infrastructure policy and coordination for agencies and policymakers.
- Combine green infrastructure with other systems; use remote sensing for planning; target planners, agencies, and disaster management.
- Acquire advanced remote sensing products, and refine analysis for disaster forecasting. Aim at research and development in meteorology and disaster response.
- Study the value of Earth observation information for Brazil, and collaborate internationally. Focus on research, trade, and platforms.
- Share radar satellite data, training, exchange knowledge. Target agencies, networks, platforms.
- Engage communities, use satellite for communication and mapping. Focus on education, disaster management, Geographic Information Systems.
- Instigate space life support for water security.

While Brazil has made strides in recent years for utilizing space applications for water security, harnessing emerging technologies, improving governance, and enhancing community preparedness, they can still work to build resilience against intensifying disasters. With strategic improvements across policy, technical, and social domains, Brazil can transition from water vulnerability to water security in stabilizing this vital resource.

The Team Project **“Space Situational Awareness, On-Orbit Collision Avoidance”** was chaired by Eric Dahlstrom, with Captain Carlos Eduardo Amaral as TP Associate Chair. According to the TP



Team, in an age where satellite technology underpins global connectivity, navigation, climate monitoring, and more, ensuring the safety and sustainability of space activities is of paramount importance. The orbital environment is witnessing rapid transformations with the launch of thousands of active satellites, including ambitious large constellation projects like Starlink and OneWeb. This expansion, however, brings forth a significant challenge: the escalating risk of collision of satellites with one another or space debris. Current data suggests that over 7,000 active satellites share orbital space with at least 36,500 medium-sized debris pieces, elevating the risk of potential collisions. The need for a transparent Space Traffic Management (STM) system is evident, and global cooperation is pivotal for the sustainable use of space. This document presents a novel

framework from the study (Murakami *et al.*, 2019) to address the challenges of STM, focusing on accurate data sharing, direct communication, and international collaboration.

Furthermore, this report examines the evolution of international space law and policy and identifies an urgent need for harmonization from the establishment of international treaties to the emergence of national legislations. The ever-evolving challenges of space debris, STM, and Space Situational Awareness (SSA) need future policy adaptations by nations.

The report underscores the importance of crafting and enforcing effective national laws and policies to enhance global space governance under the proposed international STM framework. The proposed framework is expected to act as a reference point in subsequent debates around the conceptualization and implementation of international STM. Overall, this report is a testament to the collaborative efforts of an international and interdisciplinary team, representing a collective vision to ensure that space remains secure and sustainable for all.



The Team Project *"The Role of the METAVERSE in the Future of the Space Sector"* was chaired by James L. Green, former NASA Chief Scientist, and Jacob Cohen, NASA AMES Research Center Chief Scientist, together with Maria Cecília Pereira, as TP Associate Chair. According to the TP Team, the Metaverse is the convergence of the physical and digital worlds utilizing technology, thereby bringing people together. Technology like Extended Reality (XR), which consists of Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), with Artificial Intelligence (AI), are used to create rendered 3D virtual environments where individuals can interact, play games, and learn. XR is a transformative technology that has many applications. Broadly, XR aims to enhance human functions, and as space exploration continues to rapidly

expand, the Metaverse offers creative solutions that can complement existing technology and revolutionize the space sector. This team project analyzed and proposed uses of the Metaverse in the space sector and addresses its major applications in (1) Space Operations (2) Mission Design and Planning (3) Healthcare (4) Astronaut Training (5) Space Tourism (6) Outreach and Space-Based Education, and (7) Earth Sustainability. As advancements in AI, the Internet of Things (IoT), Big Data, Blockchain, and other technologies, the benefits for these sectors are unprecedented. However, to increase its user adoption, lingering challenges were also addressed. The system design must be improved to enhance the user experience, such as making the headsets more comfortable to wear, along with enhanced graphics. Additionally, technical standards must be developed and employed, and IT challenges such as network latency, Wi-Fi, and Graphics Processing Unit (GPU) constraints must be met. Further, legal and policy concerns for matters such as digital theft, virtual crime, intellectual property infringement, privacy, and liability must be addressed. Ultimately, this project demonstrates how, despite existing challenges, the use of the Metaverse can revolutionize and enhance our capabilities for space exploration. This TP Team proposed a roadmap that encompasses past, present, and projected future uses of the Metaverse, as it applies to space.

5. Southern Hemisphere Space Studies Program – SHSSP23

The 13th Southern Hemisphere Space Studies Program was conducted onsite, in Adelaide, Australia at the Mawson Lake Campus, from 16 January to 17 February 2023, in partnership with the University of South Australia (UniSA). After two consecutive years of online delivery (SHSSP21 and SHSSP22), the Southern Hemisphere Space Studies Program (SHSSP23) was delivered in-person, continuing to support the growth of the ISU Alumni network and receiving international recognition from space agencies, space industry, governmental institutions and academia across the world.

The ISU SHSSP23 team was comprised of: James Lewis and Arif Goktug Karacalioglu as Co-Directors, Claudiu Mihai Tăiatu as Academic Coordinator, Tania Robles as Logistics Coordinator, Joel Herrmann and Nicolas Moncussi as IT Managers, and Muriel Riester as ISU Library Manager. The UniSA team was comprised of: Ross Morriss, Ruchi Sinha and Ady James as Co-Directors, Alex Ryan as Course Lead, Jan-Maree Wauer as Logistics Coordinator, Ellie Packer as Logistics Assistant and Dave Cowdrey as IT Assistant. In the delivery of the program, ISU and UniSA had the support of Teaching Associates, the Content Review Lead and Assistant, the Core Lecture Series Chair, Team Project Chairs, and instructors.

ISU has coordinated together with UniSA the planning and delivery of this five-week onsite program. In addition to UniSA's contribution to the planning and the curriculum, onsite logistical, organizational, and IT support was provided by UniSA staff. Program participants registered as UniSA students and had full access to campus library, athletic, and computing resources. Accommodation was provided for faculty, staff, and participants in modern, well-equipped, air-conditioned apartments located near the UniSA Mawson Lakes campus, a 10-minute walk from the campus.

The five-week program was modeled on and designed to complement the Northern Hemisphere SSP each year during the Southern Hemisphere summer. It attracted a diversity of students at various levels of experience from both the Southern and Northern Hemispheres. The SHSSP23 cohort had 38 participants from 15 countries. 53% of the cohort were female participants.



Fig. 18: SHSSP23 participants

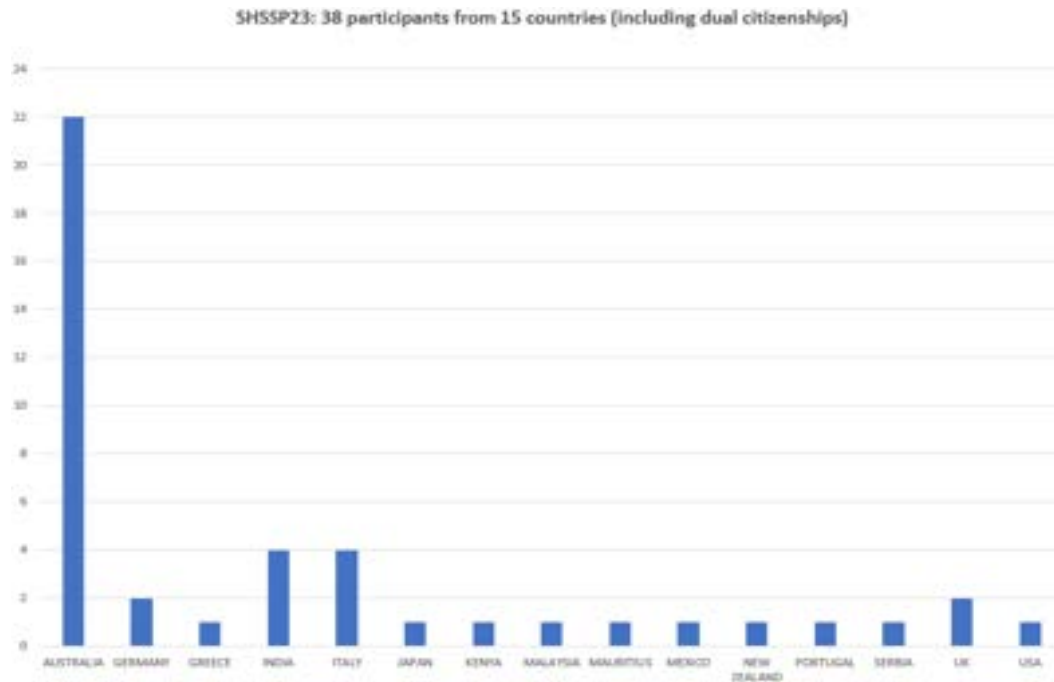


Fig. 19: Distribution of SHSSP23 participants by country

The distribution of educational backgrounds for SHSSP in 2023 continued to show a broad mix of disciplines:

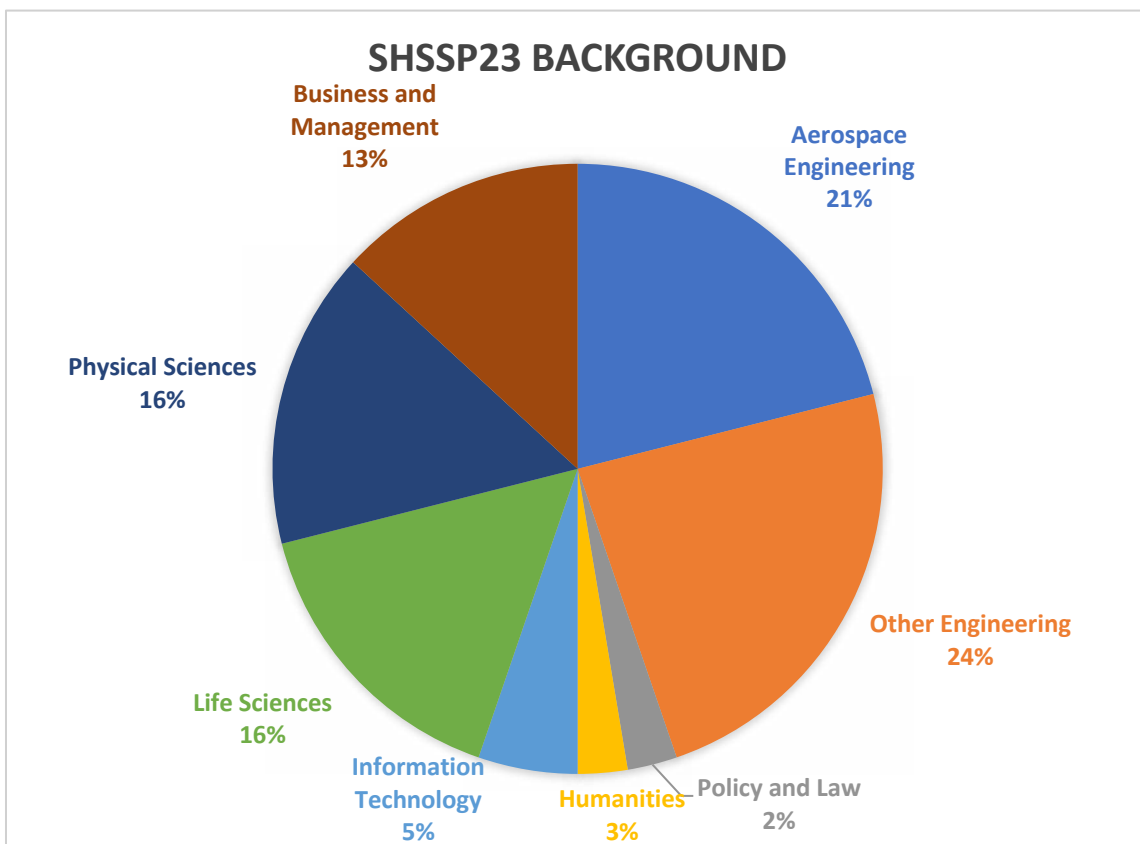
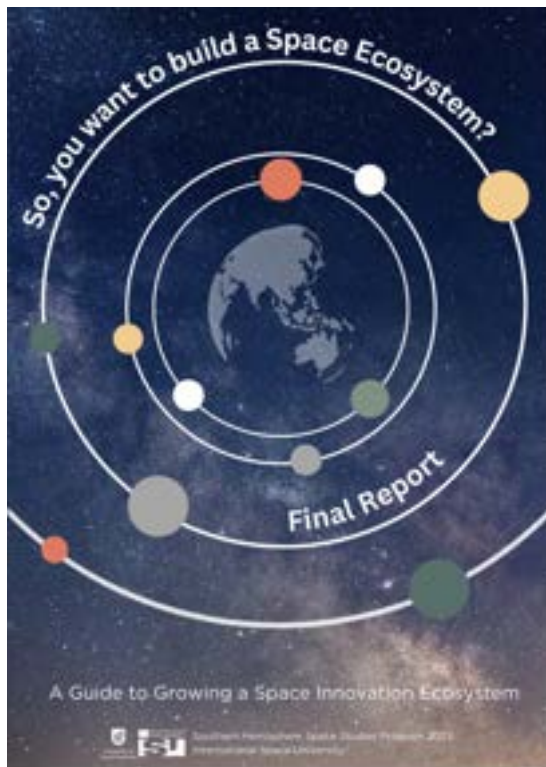


Fig. 20: Distribution of SHSSP23 participants by background

All SHSSP23 participants received Certificates of Completion from ISU and Executive Certificates from the University of South Australia. As in previous years the SHSSP23 participants are eligible to receive 50 % credit upon admission to the **UniSA Graduate Certificate in Space Studies**.

The SHSSP Core Lecture Series comprises one-third of the program, presenting 31 lectures covering the world's space activities with a focus on space applications, services, and policy. A broad understanding of the role of space, the current status of our capacity to use it, and future directions, opportunities, and challenges for the space sector was presented in a manner clearly understandable to participants from a broad range of backgrounds, who were exposed to the International, Intercultural, and Interdisciplinary aspects of space.

Another one-third of the program is allocated to hands-on workshops and the final one-third is the Team Project assignment to be completed in Week 5.



The Team Project **"So, you want to build a Space Ecosystem?"**, chaired by Emeline Paat-Dahlstrom, provides recommendations for the establishment of a space innovation ecosystem, by addressing the following objectives:

- Utilizing case studies to examine developed, emerging, and aspiring space ecosystems for the identification of factors that contribute to their success.
- Providing recommendations derived from both the public and the private sector experiences, which can be practically implemented to catalyze or grow a space innovation ecosystem at any stage of development.
- Addressing foreseen challenges including ethical considerations, and limitations with respect to resources and technical strengths required for capability creation in developing, emerging, and aspiring nations.

Through these objectives, the Team provided a detailed analysis of current successful approaches and innovative recommendations.

The Team Project **"Journey to the Moon – Technological and Legal Perspectives for Sustainable Human Presence."**, chaired by Eric Dahlstrom, has identified the most pressing challenges for Moon exploration and looked for practical solutions that would ensure a sustainable presence of the human species on the Moon. The concept of sustainability, defined as the ability to maintain a continuous long-term human program on the Moon, and how to ensure it, is the central focus around which this paper was developed. Among all the factors required to achieve sustainability, the team focused on the requirements which relate most strongly to the physical sustainability of a lunar settlement: power, in-situ resource utilization (ISRU), and human habitation.



Since the achievability of a sustainable human presence is directly correlated with the technology and research available, the paper addresses the challenge of sustainability by considering the following roadmap: near-term (until 2030), mid-term (until 2040), and long-term (until 2050). Thus, for each of these three requirements, a detailed presentation on the current status of the technologies developed is provided, presenting the challenges in sustained human settlement on the Moon, and giving recommendations for their future use, in all the various phases, for a beneficial human presence on the lunar surface. A roadmap and a series of tables summarizing the contents and the information defined are also present in the report. The constructive discussions conducted by the team have highlighted the gaps in the current international legal framework of proper

means to tackle the most pressing contemporary issues surrounding expected activity in cislunar space and on the Moon. The international legal instruments that regulate outer space have been revised proposing a new version of the international treaties, based on the Artemis Accords and the Antarctic Treaty, and picturing a two-tiered system with which to handle the international interaction among different parties, both governments and private entities, in lunar activities. At the end of this report, a series of comprehensive and conclusive recommendations have been addressed from both a technological and legal point of view.

6. Short Courses

6.1 Executive Space Course (ESC22 TLV) Tel Aviv - Onsite

From 6 to 11 November 2022, the second edition of the Executive Space Course in Tel Aviv, Israel, took place, co-organized by the International Space University (ISU) and [The Ramon Foundation](#), took place. This course was addressed primarily to professionals in Israel and the Eastern Mediterranean region, however not exclusively. It gathered 28 participants – some came from as far away as Australia, the United States of America, and Belgium – adding an additional 28 alumni to the ISU community!

More than 20 lecturers and experts were involved in this course, coordinated by the ESC22 Tel Aviv faculty Lead and ISU Board of Trustees member, Mr. Ofer Lapid: Pascale Ehrenfreund, Tal Inbar, Keren Shahar, Maayan Soumagnac, Maya Glickman (ISU alum), Danna Linn Barnett, Yariv Bash, Raphael Roettgen (ISU alum), Storm Boswick, Renana Ashkenazi, Eran Schenker, Ehud Hayun, Ran Ginosar, Danielle Palatchi, Naama Glauber (ISU alum), Dan Bloomberg, Inbar Kreiss, Ran Livne (ISU alum), Claude Rousseau (ISU alum), Jessica Meir (ISU alum), S. Pete Worden.

A week of academic learning punctuated with space-related events including [the Ramon Geolnt360](#) conference, a professional visit to [Israel Aircraft Industries \(IAI\)](#), a Space Café organized by ISU alum [Melody Korman](#) – launched by Ofer Lapid and Gil Doron the General Director of the Ramon Foundation – were followed by keynote speeches from ISU President Prof. Pascale Ehrenfreund and Dr. Pete S. Worden. Finally, ISU alum and Artemis-selected astronaut Jessica Meir provided a talk to the whole class, in in-person!

We thank the participants together with the Ramon Foundation and Mr. Ofer Lapid for ensuring that this ISU short course continues to fulfill its goals of space capacity building, attracting new players, teaching the space jargon, dispensing knowledge in a multi-disciplinary way, and allowing participants to engage professionally.



Fig. 21: ESC22 TLV participants and staff with guest speaker ISU MSS2000 astronaut Jessica Meir

6.2 Executive Space Course (ESC22 South Korea) Seoul – Onsite

The first edition of an Executive Space Course in Seoul, South Korea, was organized by the International Space University (ISU) and hosted by E&I Korea, represented by Prof. Tai Sik Lee, founder of E&I Korea. It was inaugurated by South Korean's Vice minister for Science and Technology, Mr Joo Young-chang. Mr. Lee, a member of the national assembly representing Daejong was also in attendance. The course took place from 21 to 25 November 2022 at the prestigious hotel "The Ambassador, Seoul".

Twenty-five senior participants attended ESC22 Seoul representing both private and public organizations including Korea Astronomy and Space Science Institute, Korea Institute of Science and Technology (KIST), SEMICOM, Enzychem Lifesciences, KairoSace, Korea Aerospace Research Institute (KARI), KT SAT, Uracle, Korea Aerospace Industries, Hanwha Systems, and Hyundai Rotem.

The four-and-a-half-day course aimed to provide an introduction and overview of the space sector with a special focus on space security and defense.

The participants benefited from the following lecturers' expertise:

Pascale EHRENFREUND, President ISU, President COSPAR

Bernard FOING, Director ILEWG EuroMoonMars and Professor, University Leiden

Nicolas PETER, ISU Space Policy and International Affairs, Professor of the Practice

Serge PLATTARD, Space Security and Defense, Honorary Professor at University College London

Gongling SUN, ISU Space System Engineering – Professor Space Management

Taiwo TEJUMOLA, ISU Space Engineering, Assistant Professor Space Applications

Virginia WOTRING, ISU Human Performance in Space ISU, Full Professor

We thank all the participants for their active involvement and interaction. We would also like to express our sincere gratitude to the ESC22 Seoul host "E&I Korea" and professor Tai Sik Lee in particular. We look forward to further prosperous future collaborations.



Fig. 22: ESC22 Seoul participants and staff with program host, Prof. Tai Sik Lee

6.3 Executive Space Course (ESC23) ISU Central Campus, France – Onsite

42 participants from 20 countries attended the Executive Space Course on ISU's central campus in France, from 20 to 24 March 2023. Participants coming from as far as Columbia, Canada, the United States of America, Japan, South Korea – or closer – from Liechtenstein, Luxembourg, United Kingdom, among others, were welcomed by ISU President emeritus Prof. Walter Peeters. This intensive one-week course aims to give a broad and comprehensive introduction to the space sector.

Participants explored topics from seven space disciplines – from policy law and entrepreneurship to engineering, human space flight, and satellite applications - including: a workshop on microgravity, how to build a satellite, the observation of the Sun, the discovery of space habitats, a talk by [IRCAD's](#) Dr. Forgione (research and training in the surgery of the future), and an insight into the journey of ISU alumni founded start-up – [SPIRE Global Inc.](#) – given by one of the co-founders himself – Jeroen Cappaert.

Another new and innovative learning experience at ISU, initiated by ISU Prof. Virginia Wotring, took place in the shape of a “Space lunch” during which participants not only got to taste space-like food and were introduced to the eating and living habits of the International Space Station but they also had the opportunity to meet the class of ISU's Master of Space Studies students MSS23!

Lecturers and experts who contributed to the success of the course include:

Wasim Ahmed, Founder of the Metavisionaries

Jeroen Cappaert, Co-Founder and Chief Technology Officer, Spire Global Inc

Pascale Ehrenfreund, ISU President

Bertrand Goldman, Associate Professor in Astronomy and Research Facilitator ISU

James Green, Chief Scientist of the Metavisionaries

Hugh Hill, Full Professor in Space Sciences ISU

Joerg Kreisel, Space Business and Finance Consultant JKIC

Walter Peeters, Professor of Space Business and Management ISUat , President emeritus of ISU

Nicolas Peter, Professor of the Practice in Space Policy and International Affairs ISU

Serge Plattard, Visiting Professor of Space Security and Defence, Honorary Professor at UCL

Claude Rousseau, Consultant Analysis Market Research, Northern Sky Research (NSR)

Francois Spiero, Manager, European Space Affairs, French Prime Minister's Office

Chris Stott, Entrepreneur and Founder of ManSat/Lonestar Data Holdings Inc

Gongling Sun, ISU Full Professor in Space System Engineering and Space Policy

Taiwo Tejumola, ISU Professor Space Applications – Space Engineering

Virginia Wotring, ISU Full Professor in Human Performance in Space

From the numerous posts on [social media](#) we can note that this course not only exceeded participants' expectations by providing them with a new set of skills and a global outlook on the space sector, it also allowed them to go back to their companies with ideas on how to innovate, set up fruitful business endeavors, better prepare for the future, and experience first-hand how inspirational space can be.



Fig.23: ESC23 ISU participants and staff with ISU academic leader Prof. Walter Peeters

6.4 Space Resources Professional Course - Onsite

The concepts and ideas developed during the space resources training journey initiated only four years ago by the [Colorado School of Mines](#) (CSM), the [European Space Resources Innovation Centre](#) (ESRIC), and the International Space University (ISU) are happening now!

The Space Resources Professional Course SRPC23 provided 32 participants from 11 countries, coming to Luxembourg from as far as Canada, Australia, the USA, and Singapore, with a broad overview of the space resources field, the meaning, and implications of acronyms (like SRU – Space Resources Utilization – or ISRU – In Situ, Resource Utilization) and generally taught them that there is more to space resources than mining!

The focus of this 4th edition, held from 17 to 18 April 2023 at the Luxembourg Chamber of Commerce, included topics on not only how to identify and extract resources, but also about the value of the resource, and the importance of the customer – highlighting new aspects of this activity including commercial considerations, legal and policy issues, planetary protection, and environmental and ethical aspects.

Participants divided into eleven teams and developed a space resource utilization plan to identify, extract, and use resources from space. In only a couple of hours, they came up with creative business ideas and demonstrated how best resources like lunar regolith or space debris can be used and what the business opportunities are – from inter-planetary deliveries of resources (i.e., the Amazon of space) to the utilization of metal to develop new habitats, “from Rust to Rest” presented by ISU alumna Xiao Chen Zhang, and more!

The curriculum was delivered by experts from four organizations:

Angel ABBUD MADRID – Director, Space Resources Program, Colorado School of Mines (CSM)

Dovilė MATULEVICIUTE – Legal Affairs, Luxembourg Space Agency LSA

Kathryn HADLER – Director, European Space Resources Innovation Centre (ESRIC)

Bob LAMBORAY – Policy Officer, Luxembourg Space Agency (LSA)

Beth LOMAX – Research Fellow – lunar in-situ resource utilization (ISRU) European Space Agency (ESA)

We thank all the speakers and partners for an outstanding fourth edition. We wish all participants successful career paths and successful new business lines for their employers.

ESA Lecturers

ESC - Nicolas Peter

SRPC23 - Melchiorre CONTI – Space Resources Engineer (ESA ESTEC)

7. Research and Publications

7.1 Library Service

Our Library has been busy this year, with exciting developments in the refurbishment of our spaces, to create a vibrant Library conducive to learning: new closed group working rooms, within the Library, to facilitate research and use of the information resources; a new lockable section for print collections, so that users can continue to use Library spaces outside the presence of the librarian; and new reference/checkout desk for the librarian, right at the Library entrance to better welcome and orientate users. The installation of a new ventilation plant, new lightning system, and tables and chairs will create a bright and cozy atmosphere.

We are grateful to Eurométropole de Strasbourg for investing in this project and to our colleagues on campus from the renovation project team who have been working with us, as well as to our users who have adapted to the reduced access to study space and our collections during the work this academic year.

We are all very much looking forward to a fully open Library!



Fig.24: Refurbishment of the ISU library

We continued to progress on embedding academic requirements on our Library website, related to our new accredited Master's program with an emphasis on supporting 'ethical, sustainable and open access' [to content], as well as supporting increasing information literacy skills:

- Updated the '[Citation and intellectual property](#)' section, where students will find information about why citing and referencing are important, style guides, basic rules, rights of third parties (when using other people's work), and definitions of plagiarism, student works, and copyright.



- Updated the '[Keeping current with your research](#)' section

Where we inform users about how to create search and journal alerts, and use RSS feeds and alerting tools to receive push alerts for newly published scholarly information on specific topics, authors, or journal contents.



- New list of [‘Information Sources on Open Access’](#)
The reality for many of our alumni outside academia is that finding and accessing information can be extremely tedious, with very few research tools available at their workplace. Many get a considerable amount of information from books, journals, and magazines; but outside academia, where libraries get thousands of journal subscriptions for their members, accessing full-text remains locked behind publisher paywalls.
Now, government agencies, research institutes, and educational institutions publish a wide variety of brochures, reports, white papers, annual reports, journal articles, dissertations, and theses on a range of issues of interest on Open Access.

[Open access articles and books](#)



[BASE Bielefeld Academic Search Engine](#) Voluminous search engine for academic publications

[Cambridge University Press Open Access](#)

[CORE](#) The mission of CORE is to aggregate all open access research outputs from repositories and journals worldwide and make them available to the public

[Crossref](#) is an official digital object identifier (DOI) Registration Agency of the International DOI Foundation

[Digital Commons Network](#) Full-text scholarly articles from hundreds of universities and colleges worldwide

[Directory of Open Access Repositories](#) An authoritative listing of open access repositories

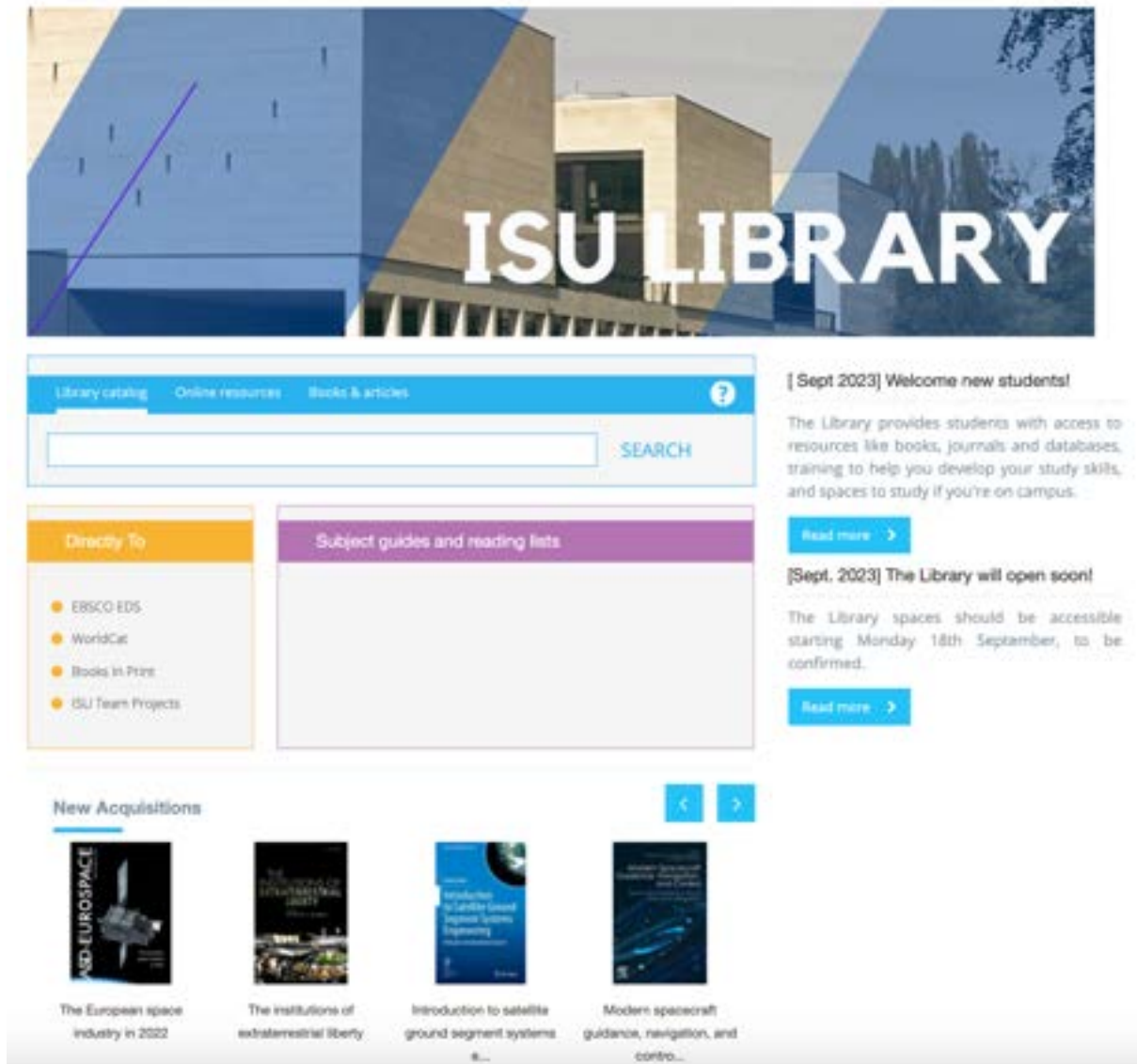
[Directory of Open Access Journals](#) An online directory that indexes and provides access to high quality, open access, peer-reviewed journals

[Directory of Open Access Books](#) The primary aim of DOAB is to increase discoverability of open access books

[E-International relations](#) Open Access scholarly books

[NASA History eBooks](#)

We invested in new electronic resources to provide our users with greater access to scholarly e-books and full-text journals, much needed for their studies and research, especially with regard to the Master’s thesis now required in our accredited Master’s program. Our users now have access to thousands of e-books and full-text journals in multidisciplinary, science, and engineering subjects. Coupled with a new SSO authentication system and a new search box on our Library website, users will now have a seamless experience navigating and accessing these resources, whether on campus or at a distance.



Finally, we have initiated discussions with UNISTRA (Université de Strasbourg) Libraries about a closer collaboration on shared collections and usage of e-resources and services.



7.2 Research Activities

ISU's resident faculty members conduct research through collaborations with academia, research organizations, and industry across the world in areas such as Space System Engineering; Nanosats; Life Sciences and Space medicine; Lunar research; Planetary science and Astrobiology; Astrophysics; Space Policy, and Entrepreneurship.

Following the publication of the Research Roadmap in February 2022, the resident faculty has explored synergies of research activities on Central Campus and strengthened the cooperation with partners from many universities and institutions in Europe and overseas, including the University of Strasbourg, ICAM, the University of Stuttgart, University Luzern, University of Kent, KyuTech, and the Physical Research Laboratory in Ahmedabad, India.

[Publications of Faculty Research are listed in Annex 2](#)

ISU faculty and students continued to pursue their research activities during the academic year. Three students, Ms. Stephania Turyk, Ms. Victoria Rendon (both part-time Teaching Associates of the MSS), and Mr. Ezequiel Gonzáles, worked on their MSS theses year, on a part-time basis.

Ms. Stephania Turyk has performed an extensive study of the current fitness testing and fitness standards for astronauts from NASA and ESA and evaluated the reliability and validity of current astronaut fitness testing measures for future ambitious missions. In her defense on 28 June 2023, she proposed a novel fitness test aimed to provide a complete fitness profile and a better ability to predict an astronaut's success in several astronaut-specific tasks.

Ms. Rendon started her Year B thesis in January 2023 and is studying how planaria, once sectioned, heal in space analog conditions: modified gravity, after radiation exposure, and in reduced magnetic field.

The purpose of the project of Mr. Gonzáles (defended on August 25, 2023), is to analyze polarimetric monitoring of nearby ultracool dwarfs obtained on the Very Large Telescope of the European Southern Observatory in Paranal, Chile, to study the distribution of dust clouds in their atmospheres.

7.2.1 Grants, proposals and acquisitions

Several external proposals to European and French funding agencies were submitted.

Grant - "Appel à Propositions de Recherche", APR, led by laboratories ICube, Strasbourg with Institut Clément Ader (ICA) - IMT MINES Albi-Carmaux, was approved by the French Space Agency CNES for 2022/2023 and will allow Ms. Danijela Ignjatovic to test additive manufacturing (AM) technologies under vacuum conditions using lunar regolith simulants applying Selective Laser Sintering (SLS) methodology. The aim of the project is to upgrade the existing laser set-up to fit the ISU Vacuum chamber. In April 2022, ISU submitted a proposal to the same CNES funding scheme (results pending) to develop a renewable electric source system for the Self-deployable Habitat for Extreme Environments (SHEE) in 2023.

In summer of 2022, ISU was awarded a grant by the European Institute of Technology and Innovation (EIT) as part of the HEI Initiative: Innovation Capacity Building for Higher Education. The progress of the 36-months EuroSpace-Hub project is discussed in the research section as well as the Incubator section of this report.

ISU was awarded a grant by the European Commission Horizon Europe (HORIZON-CL4- 2022-SPACE-01-72 - Education and skills for the EU space sector) in 2022. The 36-months project started in January 2023 under the name ASTRAIOS. According to the acronym ASTRAIOS, the goal of the project is to provide Analysis of Skills, Training, Research, And Innovation Opportunities in Space.

A project outcome is an extended view and understanding of the current and future offer of space curricula and courses in the EU-27, characterizing the demand from the European space industry in the next 10–15 years. As a member of the consortium, ISU is leading two tasks, the first one is linked to “soft skills” that are part of Work Package 2 and the second one is linked to equality, diversity, and inclusion as a part of Work Package 3. In June 2023, WP2 successfully started with the objective to deliver by the end of the year at least three workshops on the topic related to “soft skills needed by the new space sector and their best practices.” Participants will come from the upstream, midstream, and downstream industry, agencies, start-ups, and academia.

Prof. Pascale Ehrenfreund and Prof. Walter Peeters are proud to announce a grant awarded by the John Templeton Foundation entitled “Cooperation for the Future of Space Exploration” in cooperation with the Space Policy Institute at the George Washington University (duration 33 months). Several Post-doctoral students will work on this grant and join ISU in the near future. Future endeavors in space exploration are set to be more socially inclusive, synergizing technology with an important inspirational role: preparing us for the eventuality of permanent space habitation. This journey will necessitate novel strategies to encourage a collaborative approach among diverse stakeholders. The inclusion of knowledge exchange is essential, culminating in innovative agreements and necessitating the involvement of representatives from fields as diverse as anthropology, philosophy, theology, along with the young professionals who will spearhead these space advancements. Additionally, there is an urgent need to delve into more thorough studies of governance norms, ethics, regulatory frameworks, and ground-breaking adaptive practices in the space sector. Standing on the threshold of significant shifts in space exploration demands proactive thinking today and opens up opportunities for transformation that will ignite humanity’s potential in the forthcoming decades. The project’s activities will encompass academic research, international conferences, workshops, working group initiatives, and student projects, as well as ISU Team projects and using the ISU and GWU networks.

7.2.2 International Research Cooperation

ISU President Pascale Ehrenfreund has been elected as President of the Committee on Space Research (COSPAR) and started her four-year term in October 2022. The purpose of COSPAR, by its Charter from the International Council for Science (ICSU), now the International Science Council (ISC), is “to promote at an international level scientific research in space, with emphasis on the exchange of results, information and opinions, and to provide a forum, open to all scientists, for the discussion of problems that may affect scientific space research”. She also joined the Board of Directors of the Space Foundation in November 2022 and was elected Co-Chair of the Global Future Council on Space of the World Economic Forum.

In the field of **life sciences**, Dr. Wotring worked with a group of European-based pharmacists, pharmacologists, and medical doctors to propose a new **ESA Topical Team** on Pharmacological Countermeasures for Space Missions. The proposal was awarded and work began in the fall of 2022. Dr. Wotring is now a member of the ESA Topical Team for “Space Omics”. She is also the sole life scientist working with a group of 41 European engineers on a proposal to eCOST developing new sensors that could be used for noninvasive monitoring of biological systems.

In the field of **astronomy**, Dr. Goldman has joined **the Euclid Consortium** that coordinates research made possible by the ESA Euclid mission, and was selected as deputy lead of the Science Working Group on the Milky Way and the Resolved Stellar Populations.

In the field of **space applications** Ms. Danijela Ignjatovic has continued collaboration with the ICube laboratory, ICAM Strasbourg, and Institut Clément Ader (ICA) - IMT MINES Albi-Carmaux on the creation of 2D structures by selected laser melting of diverse lunar simulants and by optimizing the sintering process through simulation. To properly equipping an extraterrestrial Additive manufacturing AM laboratory, Aalen University and Cracow University of Technology were welcomed as collaborative partners.

For all partners with different expertise, a further study will include testing of the compactness of various powders in a specifically design powder bed and spreader (hopper, blade and roller), tests with a galvanic head instead of a stage to reach higher speed, tests in a vacuum chamber, the use of other lunar soil simulants and optimization of the multi-physics model.

As a second project in space applications field, an independent lunar navigation system is applied to space mining and to Moon exploration that is jointly developed between ISU and the University of Ljubljana, and financially supported by Velenje Coal Mine, Slovenia.

ISU remains an active participant in the STEM Outreach/Societal connection Working group of the **Orbital Reef University Advisory Council**.

ISU has named [New Space](#) its Official Journal. This partnership between ISU and New Space will further the connections within the space research community and benefit all research experts within the field.

7.2.3 Research of Resident Faculty Member

As in the previous year, the faculty pursued research in the following fields:

Dr. Taiwo Tejumola

In the field of System Engineering and Nanosats, Dr. Tejumola primarily focused on two projects:

1) PLASMACube

PLASMACube is a miniaturized low-cost plasma measurement system under development at the Space Systems Laboratory; it is aimed to be a plug-and-play instrument for characterizing Low Earth orbit plasma (see Fig. 25). PLASMACube is contributing to one of the mission payloads of the ROMEO satellite currently under development at the Institute of Space Systems of the University of Stuttgart that would be integrated as a mission payload of the ROMEO Satellite. The main objective of the satellite is to develop a cost-efficient satellite bus that demonstrates new technologies in low (LEO) and medium (MEO) Earth orbits. The plasma instrumentation will apply the principle of double Langmuir probe for the characterization of transitional orbit (LEO to MEO) of the satellite. The payload passed the preliminary design review last December and further environmental tests and validations were carried out in June 2023 at the Kyushu Institute of technology, Kitakyushu, Japan.

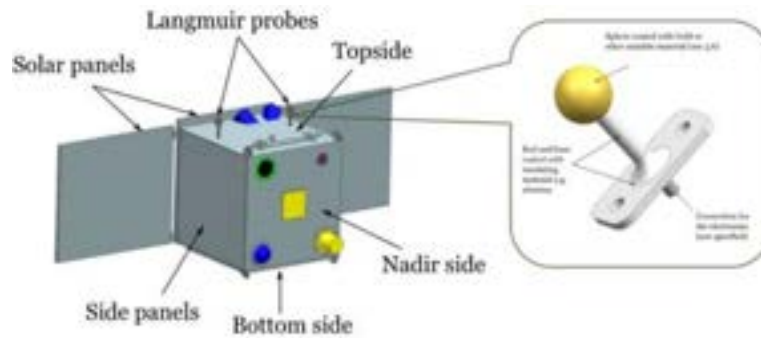


Fig.25: Schematic of PLASMACube as a payload of ROMEO Satellite

2) Small Satellites Standardization Project

ISU Space Systems Engineering Laboratory is contributing to the development of a technical standard for CubeSat interior configuration, under ISO TC20/SC 14/WG1, which is a sub-technical group under ISO/TC 20/SC 14: Space systems, Development and Implementation. This project is composed of a global consortium of universities, industry, and space agencies involved in the development, operation, and utilization of CubeSats to achieve specific mission objectives. The standard is aimed at defining more clearly interior mechanical interfaces and connections for power, data, safety requirements, and fault isolation and recovery. The interdisciplinary research team harnesses applied integrated systems engineering and incorporates best practices gathered from data from mission development to in-orbit operations. The primary objective is to establish standardized protocols for small satellite development, amplifying mission assurance and contributing to the enhancement of global space sustainability initiatives.

The standard that is currently in the working draft (WD) stage, when completed shall contribute to shortening the time required to design, develop, assemble, integrate, and test a CubeSat by clarifying the interface from the beginning of the satellite project. The standard also aims to promote international trade of CubeSat units/platforms, enhance international collaboration, and create a more sustainable space environment.

ISU's Space Systems Engineering Laboratory, in collaboration with the Industrial Engineering department of the Faculty of Engineering (UNISTRA), are implementing a doctoral thesis funded under the French government "Solidarity Fund for innovative projects, civil societies, the Francophonie and human development of the Ministry for Europe and Foreign Affairs" under the framework of the Support for the Development of French Higher Education in Africa (ADESFA) – vocational and vocational training component. The Ph.D. research is focused on innovative systems engineering for small satellite development.

Ms Danijela Ignjatovic

Together with Professors from the University of Ljubljana, department of Mining and Geotechnology, Slovenia, an article based on an innovative solution for regional navigation on the Moon was published in March 2023. The manuscript was published in Q2 ranked MDPI journal reaching high interest from the ESA- Moonlight Initiative team and ongoing Moon missions-related companies (iSpace, Maana Electric, LIST, etc.)

This paper solves a problem of centimeter-precision positioning on the Moon's surface. The solution is called Lunar Regional Navigation Transceiver System (LRNTS). It is based on a network of transceiver facilities, holding onboard both navigation transmitters and receivers. Transmitting modules of LRNTS act in the same way as the Global Navigation Satellite Systems (GNSS) space segment, sending navigation messages to the receivers.

Receiving modules are needed for self-calibration of LRNTS to calculate their coordinates. In this paper, 12 different LRNTS-simulated configuration setups within the Shackleton Crater are tested against positioning accuracy and visibility along the crater. The results show that the LRNTS of nine transceivers can achieve sub-centimeter horizontal and better than 2 cm vertical accuracy, with consistent visibility of six and more transceivers throughout the Shackleton Crater. The concept is shown in the Fig. 26, including pointing interconnections and visibility between LRNTS sites.

In October 2022, three papers were presented at IAC22 in collaboration between ISU, ICAM Strasbourg, and Johns Hopkins University. ISU was represented by MSS22 students, Kyunghwan Kim, Martina Dimoska, and Ms Ignjtaovic. ICAM - Strasbourg contributed with Dr. Chabrol Grégoire, and Johns Hopkins University with Dr. Radames Cordero.

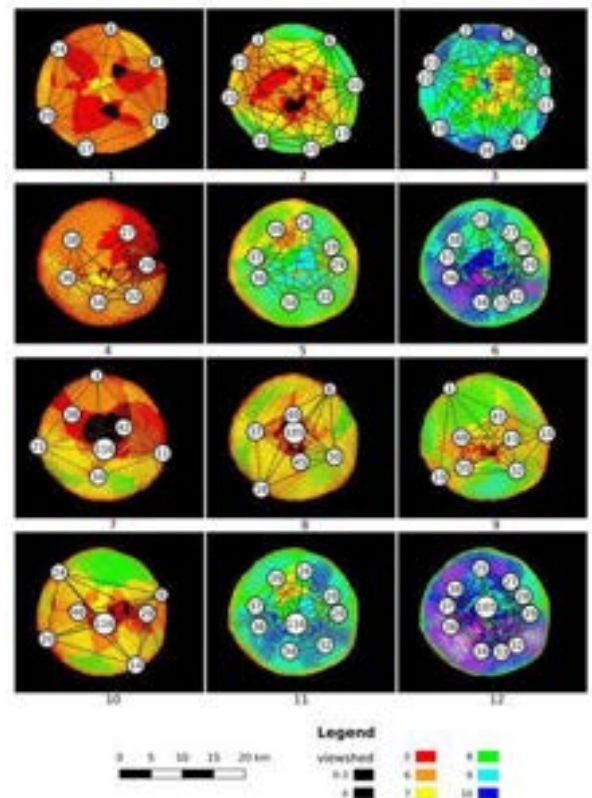


Fig.26: LRNTS-simulated configuration setups within the Shackleton Crater are tested against positioning accuracy and visibility along the crater

The papers presented:

1. Experimental investigation of lunar regolith simulants mixing other materials in selective laser processing
2. Setting up a lunar dust 3D solar printer in collaboration with ECAM Strasbourg improvements of the 3D solar printer and its capabilities in comparison with other additive manufacturing technologies
3. Protection against radiation with the use of fungi - multipurpose use of mushrooms

The experimental part of research was done in the iCube laboratories using AM instrumentations supported via a grant APR CNES 2022/2023 grant and grants from previous years. Through these successful students’ research projects, the collaboration between ISU and iCube, ICAM, ITM, Mine Albi will continue in upcoming academic year.

Dr Hugh Hill

Prof. Hill’s projects include Masters-level theses involving an advanced version of ISU’s portable, 2.5-meter, experimental drop tower. The collaboration is on the part of both ISU and Universidade Técnica de Lisboa (ITL). Essentially, one or two ITL students will work with Prof. Hill and ITL colleagues to design, construct and test a state-of-the-art drop tower worthy of the needs of European undergraduate students. Prof. Hill is also collaborating, and publishing, in the fields of AI and SETI, with colleagues from the Hebrew University of Jerusalem (HUJ). Finally, Prof. Hill contributed to several, international, peer-reviewed publications in the interdisciplinary fields of Astrochemistry and Astrobiology. The forthcoming publications were the result, again, of ongoing international collaboration, e.g., with MSS 2004 alumnus, Dr. Bhalamurugan Sivaraman, Atomic Molecular and Optical Physics Division, Physical Research Laboratory (PRL), Ahmedabad, India. ISU had recently the honor (via social media) to announce that Dr. Sivaraman had been promoted to Full Professor at PRL. ISU congratulates Prof. Sivaraman and we look forward to our continued and robust collaboration.

Recent ISU/PRL collaboration resulted in the following, peer-reviewed publications, including one, “N-graphene synthesized in astrochemical ices”, which made the front cover of “AstroPAH” in March, 2023 (see Fig. 27).



Fig. 27: N-graphene synthesized in astronomical ice revealed by high-resolution transmission electron microscopy (HR-TEM). a) HRTEM image of a large sheet of N-graphene. b) zoom-in of the exagonal pattern of N-graphene. c) corresponding diffraction pattern. Sivaraman et al., 2023

Dr. Bertrand Goldman

Dr. Goldman has worked toward the publication of the legacy data of the microlensing project EROS at the Strasbourg Data Centre (CDS) of the Strasbourg Observatory. The first part to be deposited at the CDS contain time-resolved observations of the Magellan Clouds with up to hundreds of observations over the two Milky Way neighbor galaxies.

The ESA Euclid mission was successfully launched from Cape Canaveral on 1 July 2023 and is currently being commissioned (see Fig.28). The mission will perform a wide survey of more than a third of the whole sky to unprecedented depths in four filters, as well as several deep fields. While the main goal of the mission is cosmology and the study of the content of the Universe, the data will allow the detection and study of a wealth of ultracool dwarfs, leading Dr. Goldman to join the Euclid Consortium four years ago. He was recently selected as Deputy Lead of the corresponding working group, the Milky Way and Resolved Stellar Populations SWG, and contributes to the Early Release Observations proposal led by Dr. Martin, whose observations will be conducted in September 2023.



Fig.28: One quarter of one in 36 CCDs of the Euclid VIS imager, from the Early commissioning test image, July 2023

Finally, a unique data set of high-precision, time-sampled polarimetric imaging of three brown dwarfs, obtained with the FORS2 imager on the Very Large Telescope of the European Southern Observatory, constitutes the topic of an MSS Year B thesis to be defended on August 25, 2023. Polarimetric data allow to constrain the distribution of dust in the atmosphere of ultra-cool dwarfs (250–2500 K). The preliminary results were presented in conference proceedings in January as well as in a conference paper at the Annual meeting of the French Astronomy and Astrophysics Society here in Strasbourg. Our preliminary analysis shows hints of possible low-level polarization in one target over a fraction of their rotational period, pointing indeed to variations in the cloud deck, but future observations are needed to confirm our low signal-to-noise detection.

In addition, Dr. Goldman contributed to the project *Ma Terre en 180 minutes*, dedicated to develop an innovative game-based transition support system to build scenarios of greenhouse gas (GHG) emission reductions in the academic community. In this board game, the participants belonging to the research community and its governance bodies immerse themselves into fictional characters, to simulate the behavior of real research groups. Gratiot et al. (2023), present a statistical analysis of the paths favored by the participants to reduce GHG emissions and, more crucially, illustrate how to conduct negotiations to bring out alternatives to carbonized activities.

Dr. Virginia Wotring

Dr. Wotring, with collaborator and ISU Global Faculty Members Willian da Silveira and Tricia Larose, and MSS22 student Geraldine Vitry, published a paper in *iScience*, a high impact factor journal in the Cell Press group. This paper began as a workshop in the MSS Omics Elective and continued during an internship in Dr. da Silveira's lab in the UK. Dr. Vitry is now continuing Omics research in the lab of Evagelia Laiakis, Georgetown University, one of the visiting lecturers in the Omics Elective.

Dr. Wotring remains active in the ESA Topical Teams for Space Omics and also in Pharmacological Countermeasures. Based on these collaborations, arrangements have been made for an Omics intern in winter/spring and two pharmacy interns in spring to work on the ongoing planarian project. There has been an Engineering intern from University of Strasbourg in the lab over the summer building a duplicate of the borrowed microgravity simulation device, the random positioning machine. Dr. Wotring and Tejumola are co-mentors for this internship that is mostly engineering but has applications in biomedicine. The intern is adapting the design to better suit the needs of our planarians and specific experiments.

Dr. Wotring has been working with MetaVisionaries on a new format ESC for November in the UK. It will offer detailed lectures and workshops on the single topic "Medicines in Space" and is aimed at participants with life science backgrounds, especially pharmacists (who have a requirement for periodic continuing education).

Dr. Wotring has contributed to multiple grant proposals in the academic year 2022/2023 and awaits notification regarding their funding. Most of these involve the ongoing planarian research in the laboratory. MSS22 Thesis student Victoria Redon is now preparing her first manuscript for publication. She is studying wound healing in space analogs under Dr. Wotring in the Space Life Sciences Lab at ISU Central Campus. Planaria have the ability to regenerate after sectioning, and her project is to measure the effects of simulated microgravity on regeneration.

The photos in Fig. 29, from a single animal exposed to simulated microgravity, show regeneration of its central trunk to form both a new tail and a new head over 12 days. Note that new eye spots are clearly visible on Day 9. The next phase of this experiment is to test when these newly developed eyes become functional using a new apparatus under construction in the laboratory.

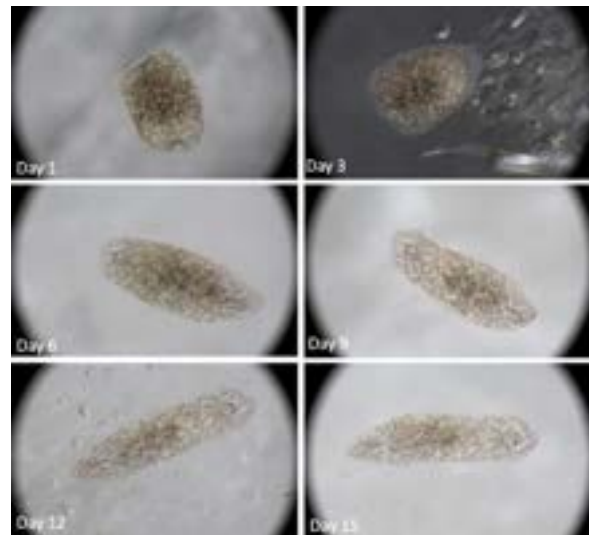


Fig. 29 Planaria exposed to simulated microgravity, explanation see text.

Dr. Walter Peeters, Nicolas Peter, and Gongling Sun

The majority of research in the reporting period, in the framework of the Space Policy and Entrepreneurship Lab at ISU (SPEL) has been linked to the EuroSpaceHub grant. The purpose of this grant is to act as a global hub and bridge the gap between academics, practitioners, and professionals in the NewSpace economy. In view of this, under the EIT HEI grant mechanism (see further under <https://eit-hei.eu>) a consortium was formed between four Institutes of Higher Education (HEI) and experts in space communication (see also Incubator section). The grant, financed by the European Union, is based upon a number of deliverables such as:

- The creation of new educational programs for entrepreneurship and innovation for the space sector.
- Create a new tech transfer strategy as liaison between universities and entrepreneurial ecosystems.
- Develop a strategy for space innovation ecosystem orchestration. Connect universities and industry by the creation of digital platforms.
- Connect space academics with space professionals for workshops and training.

A direct transfer of these studies is implemented in the ISU Incubator, covering aspects such as business plan evaluation and start-up support and financing. Indirectly, the growing academic reputation of ISU in the field of Entrepreneurship is reflected in the nominations of Prof. Peter and Prof. Peeters to the editorial board of the NewSpace Journal. Both are regularly solicited for peer reviews in the field of entrepreneurship for - among others - the NewSpace Journal, Space Policy Journal, and Astropolitics Journal.

8. Start-up Incubator

8.1 News from the start-ups

As the usual incubation period is 2-3 years, incubatees of the first ISU Incubator cohort have grown to the extent that they now are becoming established companies, leaving the Incubator for locations in business parks.

This is in the first place the case of **LeanSpace**, which hired several staff members (several of them are ISU alumni) and successfully obtained Round A financing. Due to this expansion, they **moved to other premises** where they have more office space to comply with their growth, while **leaving a liaison office in ISU** to ensure ongoing in contact with ISU to hire new talent.

A second company, Watershed Monitoring, has now a sufficient turnover and contract volume to become self-supporting and is **leaving the Incubator but will keep in touch with the Incubator team**.

In September 2022, two new startups joined the Incubator, **SpacePharma** and **Ewosmart**. Since then, these companies have expanded their activities and events. On April 18, 2023, **SpacePharma organized the official inauguration of its offices** in collaboration with ISU and Invest Eastern France. The press was present, as were local politicians, and France3 produced a report on the occasion ([JT 19/20 - Alsace les replays et vidéos en streaming Grand Est \(francetvinfo.fr\)](#)), which was aired on the local TV channel.



Fig.30: Inauguration of Spacepharma EU to the press in the ISU meeting room on 18/05/2023

As for Ewosmart, the startup has gained recognition and taken part in a number of national and international events, including missions to Africa, in collaboration with Benin.

Two companies passed the ESA-BIC selection committee and got funded: **Grapehawk** and **Ewosmart**. Several new start-ups are in the process of incubation in the fields of: production of human material in space; implementation of an SSP-originated TP project in the field of medical crystal growth in space; and development of a space toolkit for every amateur to understand the satellite building and operation in a simple, entertaining way.

8.2 Development of the Incubator Visibility

Over the past year, the Incubator has developed its visibility in terms of communication, marketing, and events.

With the financial help of the local ecosystem, where space applications are part of the strategy, further efforts were initiated to improve the attractiveness of the Incubator. Of these initiatives we can mention:

- Establishment of a dedicated ISU Incubator website, which can be found under <https://incubator.isunet.edu/>
- Development of banners and material to draw attention to the ISU Incubator (bags, banners, stickers and other marketing tools)
- Organization of the 4th Cassini Hackathon (European Commission and EUSPA Initiative) in November 2022 and participation in the Leanspace hackathon at SpaceTech Expo Bremen 2022.
- Expansion of the services to the incubatees, such as legal/administrative advice, welcome packages to explain the Incubator procedures, and French administrative procedures.
- Creation of training courses for startups on topics such as hiring employees in France, presentation of local financing programs, and many others.

TRAININGS #1
at the incubator
Welcoming your first employees without legal pitfalls

Pauline HENRY
Human Resources and
Legal Manager at ISU

In order to bring more support to the companies present in the incubator, we have decided to launch a training cycle open to all persons belonging to a start-up incubated at the ISU. These sessions will be adapted to the needs and questions of the different companies and shared between all of them.

The first session will focus on the arrival of employees, including:

- Drafting an employment contract
- Making declarations
- Fundamentals (occupational medicine, payroll, paid leave, etc.)

This session, targeting Frenchspeakers, will be conducted in French with the possibility of having access to the content in English. Translated from English.

29/06/2023
15h
(CEST)

Onsite at ISU
(Meeting room)
or Online
(Zoom)

Fig.31: Example of training delivered for the startups by Pauline Henry

Presence at several events (International Astronautical Congress in Paris, New Space Europe in Luxembourg, New Space Economy ExpoForum in Roma, Space Resources Week in Luxembourg, 360 Grand Est in Strasbourg, and Les Assises du New Space in Paris).

An example of the Incubator specific outreach can be seen below, where the Incubator was promoted at the IAC2022 event in Paris.



Fig.32: The incubator on the ISU booth at IAC 2022 in Paris

8.3 The Incubator organized its first hackathon

During the weekend of 4 to 6 November 2022, the Incubator hosted the 4th edition of the Cassini Hackathon.

Following a call for applications to become a local organizer of the 4th Cassini Hackathon, ISU was selected to represent France at the event. Co-organized by the European Commission and European Union Agency for the Space Programme (EUSPA), the Cassini Hackathon brought together 10 different countries.

The theme was “Space and the Financial World” and participants worked on the following topics: Enabling green and sustainable investment; Innovating financial tools and technologies; Advancing global market intelligence.

ISU welcomed **five teams**, both on-site and in hybrid format, as well as numerous experts from **the European Space Agency, PwC, Karista, SES, ICube-SERTIT, and many more.**

Here are a few links to the event:

University of Strasbourg: <https://entreprises.unistra.fr/actualites/actualite/news/le-hackathon-cassini-les-inscriptions-sont-ouvertes/>

EUSPA: <https://www.euspa.europa.eu/international-space-university-organize-4th-cassini-hackathon>

SpaceWatch Global: <https://spacewatch.global/2022/10/international-space-university-to-organize-4th-cassini-hackathon/>



Fig.33: Winning team of the 4th Cassini Hackathon with the jury



Fig.34: Victoria Carter-Cortez (PwC), Arlande Joerger (Ewosmart), Nicolas Peter (ISU Incubator), Coralie Lhabitant (ISU Incubator)

8.4 Development of partnerships

The link with **the ESA-BIC initiative is maintained and strengthened**, so that, beyond local seed funding, a number of start-ups are benefiting from the additional financial support and advice under this system.

Since June, 2023, another supporting mechanism is **the membership of the ISU Incubator in the FrenchTech network through FrenchTech Est**, which, among others, is an asset for start-ups for visa support and access to additional funding. This partnership with French Tech Est will facilitate certain administrative procedures for start-ups with the help of the Incubator, as well as the creation of joint local events (conferences on the space sector, presentation of French tech programs to startups incubated at ISU).



Fig.35: French Tech Est Network logo

At the same time, the link with another local Incubator, **SEMIA, has been renewed**, which provides the start-ups with further support on proof-of-concept and marketing.

Last but not least, relations with **the Eurométropole de Strasbourg** have been further strengthened, and work continues in close collaboration.

8.5 EuroSpaceHub Project

Another aspect linked to the growing reputation of ISU in entrepreneurship is the inclusion of **ISU in a consortium, financed by the EU, to develop programs on entrepreneurial skills** with the main goal of adding such training sessions to the classical space science and engineering curriculum. Under this grant, an analysis was made of the requirements for such programs, and several variants were developed with different durations, varying from four days to even a five-month full-fledged curriculum to be linked to existing space curricula. The project is called EuroSpaceHub and is intended to **strengthen the knowledge triangle between business, education, and innovation**.



Fig.36: EuroSpaceHub logo

For this project, the team travels to events linked to the project as well as to working meetings at the various partners' sites, as was the case in February 2023 when the team went to Vilnius for a working meeting at Vilnius Tech.



Fig.37: Vilnius Consortium Work Meeting 1

EuroSpaceHub supports student events such as the **Business Plan Competition**. Over a two-week period at ISU, students are taught about entrepreneurship and innovation in the space industry and then asked to work in groups on a project to be presented to a jury at the end of the event. These moments of learning create a link between universities, industry, and entrepreneurship.



Fig.38: The winning team of the Business Plan Competition with EuroSpaceHub sweaters

9. Alumni Affairs

9.1 The ISU Alumni Statistics

From 1988 to 2023, the ISU community has proudly connected 5600 alumni from 112 countries.



Fig.39: world map showcasing the diverse origins of our ISU alumni

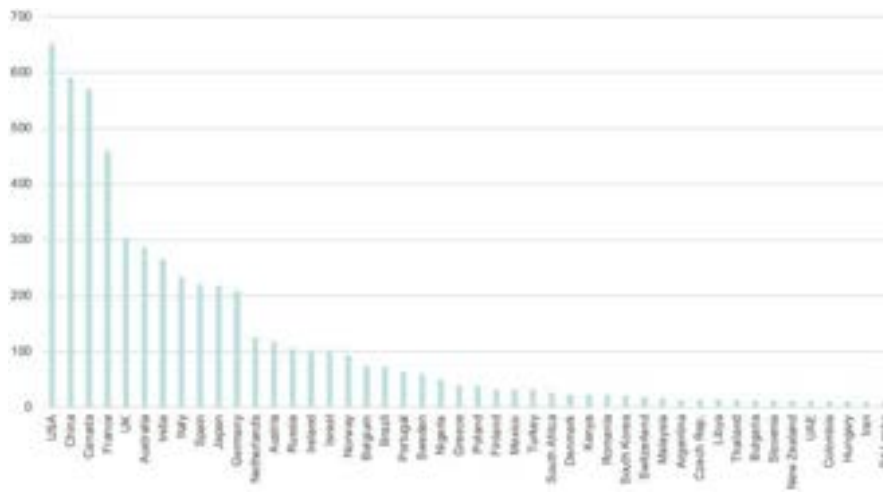


Fig.40: Largest ISU Countries (+10 Alumni)

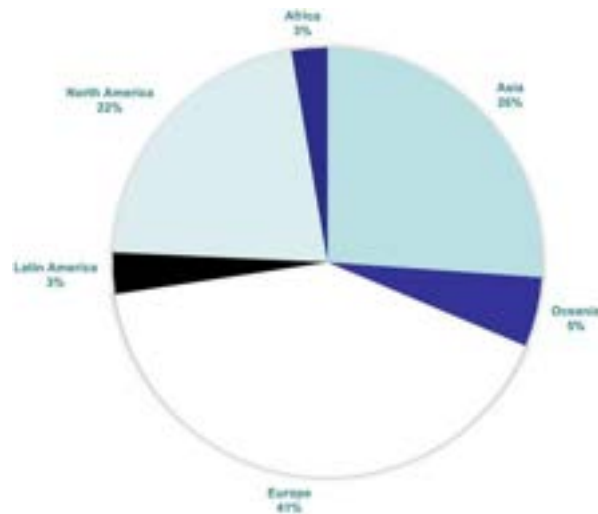


Fig.41: ISU Alumni Geographical Zones

9.2 Success Stories

"What do a NASA astronaut, the CEO of a major aerospace company, and a leading space policy expert have in common?" They are all distinguished alumni of the International Space University. Founded in 1987, ISU has been a pioneering institution, dedicated to the interdisciplinary education and training of future leaders in the space community.

Alumni serve as the testament to an educational institution's quality, impact, and reach. At ISU, the accomplishments of its graduates spread across various sectors within the space industry and beyond, demonstrating the university's role as a springboard for innovation, leadership, and international cooperation. From piloting spacecraft to shaping international space law, and from advancing scientific research to spearheading commercial space ventures, ISU alumni are making a profound impact on humanity's engagement with outer space.

SSP06 Erin Tranfield Telley: a scientist spearheading advancement in electron microscopy, recently interviewed by The Wiley Analytical Science Magazine, testified how ISU impacted her professional career.

E. Tranfield: "The International Space University (ISU) changed my life. That sounds overly dramatic, but it really did change my life. At ISU, I saw adults dreaming big. I learned about fascinating topics and fields (like space law!) and I met regular people who had done extraordinary things. By seeing the real people behind the huge science and exploration achievements, I began to hope I could also do extraordinary things. I also met astronauts like Buzz Aldrin and Bob Thirsk and hearing their stories and seeing their passion was extraordinary..."

The full article can be read [here](#).



Fig.42: SSP06 Dr. Erin Tranfield

9.3 Alumni Conference

ISU Alumni Conference 2023 was celebrated during the 35th SSP in Brazil

The International Space University's (ISU) annual Alumni Conference took place from 27 to 29 July 2023. Fifteen ISU alumni came from all over the world to join the SSP23 alumni staff and participants in Sao José dos Campos, Brazil. They assembled for an unforgettable reunion and celebration of ISU's 35th Space Studies Program, coordinated by **SSP22 alumnus Erik Busnello Imbuzeiro**.

SSP22 alumnus Leonard de Guzman summarizes this gathering in the write-up below.

"SSP23 Alumni Conference kicked-off with a stunning visit to Paraty to explore the incredible natural beauty Brazil has to offer. Being amongst the greenery in the mountains and getting out onto the water to experience the gentle waves of the ocean. The traditional SSP culture night wrapped up our first day, with the UK, Italy, Israel, and the Netherlands showcasing their cultures for all to enjoy - thank you for the stroopwafel!! I still have some stroopwafels left over from when I was a participant at SSP22 in Oeiras, Portugal, and am happily adding to my stash after this year's Alumni Conference!

On Friday, we were hosted at the National Institute of Space Research (INPE), a research unit of the Brazilian Ministry of Science, Technology, and Innovation, which included a visit to their satellite assembly and testing facilities, as well as learning about the Embrace Program - Brazilian Studies and Monitoring of Space Weather. We had the unique experience of a churrascaria for lunch (what others may know more colloquially as a Brazilian steakhouse), sampling delicious preparations of beef, pork, and chicken. The SSP23 participants did not disappoint with their Space Masquerade costumes, with Cat-Women of the Moon and Canada Arm tied for best individual costume, and a crew capsule from India winning the best group costume. It brought back wonderful memories of when I was a participant last year, trying to convince 14 other fellow participants to join me building space station modules out of foam and cardboard, then "dressing up" as a space station!

Finally, on Saturday, we enjoyed a wonderfully prepared brunch before visiting the Brazilian Aerospace Memorial, an indoor-outdoor museum, and making a slight unscheduled detour to a food festival, which once again did not disappoint (a recurring theme for all things Brazilian cuisine)! And whilst we may not have spotted the elusive capybara, we did spot evidence of their presence, which was good enough.

A huge Thank You to the Local Organizing Committee of SSP23, the Brazilian Space Agency, the National Institute of Space Research, the Brazilian Ministry of Science, Technology, and Innovation, and ISU for hosting such a wonderful and memorable Alumni Conference. It gave many of us the chance to reconnect and rekindle relationships after many years apart, and it gave the opportunity for newer members of the alumni community (like myself) the chance to genuinely feel part of the international ISU family. It's one thing to complete an SSP and call oneself an "alum". It's a whole enriching and empowering experience to attend an Alumni Conference and genuinely feel part of the family. Thank You!"

10. Faculty and Executive appointments

10.1 New Faculty appointments

The professionals listed below have accumulated sufficient teaching time at ISU to join the Global Faculty, and they have agreed to contribute with their expertise to the ISU academic, research, and professional development programs.

The updated list of over 160 faculty members is accessible on [the ISU website](#) with links to the profile of each individual.

The procedures for faculty eligibility, appointments, and currency are established in [the ISU Academic Handbook](#).

Promoted to Full members of the ISU Global Faculty: Robbert Jan Postema, Scott Ritter, Todd Mosher

Appointed Adjunct Faculty: Justin Karl, Joerg Kreisel, Veronica La Regina, Li Shean Toh, Vanessa Stroh, Imre Vegh

Appointed Emeritus: Steve Brody, Angie Buckley, Stefano Fiorolli, Ray Williamson

Elections to the Academic Board took place in July 2023. For reference, the current Academic Council Members are:

Volker Damann (Germany) Chair of the Academic Council, ESA (retired); Lucy Stojak (Canada), Vice Chair of the Academic Council, HEC Montreal, Canada

Jacob Cohen, NASA Ames Research Center, USA

Daniel Garcia Yarnoz, EUSPA, Spain

Natalia Larrea Brito, Euroconsult USA

Maria Antonietta Perino, Thales Alenia Space, Italy

Gary Martin, NASA (Retired), USA

Su-Yin Tan, University of Waterloo, Canada

Virginia Wotring, International Space University, France

10.2 New Executive appointments

The International Space University's (ISU) Board of Trustees has appointed Dr. Ken Davidian as Vice President for its North American Operations. He took office on 1 September 2022 succeeding Mr. Gary Martin, who served in the post since 2020.

James Lewis, from NASA JSC, joined ISU in September 2022 as new SSP Director, seconded from NASA JSC.

11. Special events and outreach

11.1 Special events

International Astronautical Congress

The International Astronautical Congress is the most important event for ISU in terms of recruiting new candidates for its programs. The IAC22 in Paris was the largest ever IAC with more than 9000 participants. The ISU President served also as the IAF President and opened the large conference. IAC22's Science and Academic Day breakfast entitled:

“Developing Success from Failures” and moderated by Deganit Paikowsky, featured four ISU panelists:

Emmanuelle David (SSP13), Executive Director EPFL; Ken Davidian (SSP89), VP for North American Operations ISU; Yoav Landsman (SSP19), CEO Moonscape; and Jenna Tiwana (MSS17), European Business Development & Partnerships Officer, Ispace Inc. The traditional IAC SGAC/ISU/IAF YP networking event allowed 600 people to exchange contacts, information, ideas, and reminisce about the past in an informal setting. More than 100 alumni presented their papers and ISU team projects or scouted for new business opportunities.

11.2 Outreach

For the third time, ISU invited prospective students and participants to join a conference to learn more about those programs we are offering in 2023. This year, the online open day was dedicated to the Asia-Pacific area and lasted for two hours. High-profile guests from the region with various ISU experience illustrated the value of ISU education.

This year again, ISU contributed to an international competition, led by our partner Space Science Engineering Foundation (SSEF), with Dr. Goldman acting as a juror of the competition. Guided by space experts, teenagers joined forces to prepare a project for space exploration and human settlement. This European-wide event was held virtually. The impact on the participants to the competition is profound, illustrated by the fact that several participants from previous editions return to support the event and gain confidence that they could pursue a career in Science, Technology, Engineering and Mathematics (STEM), and the space sector.



Fig.43: Dr. Goldman presenting ISU and explaining why and how astronomers use space assets to the high-school students

With the end of the restrictions due to the pandemic, ISU could resume welcoming local school classes to visit its campus and be introduced to space exploration in an interdisciplinary way. On November 23 and 24, 2022, supported by French-speaking MSS students, Dr. Goldman welcomed more than one hundred students from local high schools to a conference on space observatories (see Fig.43) and visits to the laboratories. The visit resulted in an [article](#) in the school journal. In addition, two middle-school students came for an observation internship and stayed one week at ISU, during which they met the Master class and ISU staff and learned about their activities. ISU members also left the ISU campus to meet the public of all ages. Dr. Spiero visited the Strasbourg Pasteur High School and introduced the students to the exciting prospect of crewed exploration of the Moon and Mars. At the opposite end of the age spectrum, two Master's students volunteer to visit the residents of a Strasbourg nursing home to discuss with them the search for life in the Universe.



Fig.44: Dr. Spiero in the library of the Strasbourg high school Pasteur presenting European space exploration programs

Finally, in April 2023, the German TV producer Pro7 used our **Self-deployable Habitat for Extreme Environments** SHEE habitat to host their science and technology flagship show Galileo, which is watched daily at 19:00 by hundreds of thousands of viewers. They dedicated a special program on Moon habitats and presented SHEE. Two journalists performed a serious 48-hour analog mission that was broadcasted live on the TV channel application. Three ISU students provided material for the show: as part of their MSS Individual Projects; two students prepared a hydroponic system that the journalists harvested; a third student provided artwork that was installed by the journalists.



Fig.45: the SHEE habitat hosted at the German film studios Bavaria Filmstadt near Munich, shortly before the analog mission started.



Fig.46: the two journalists interacting with the artwork of MSS23 student Aoife Van Linden Tol.

12. International Relations

ISU is made up of a unique global network with a Central Campus in Strasbourg, hubs in the USA and the Asia- Pacific region, and partnerships with leading space organizations around the world. ISU is supported by government agencies, corporations, foundations, and individuals worldwide that recognize the value of the University in promoting international cooperation and in developing the global space workforce. In 2022/2023 ISU signed MoUs with several key organizations to excel in space education and science cooperation.

Collaboration between ISU and JAXA

On 23rd September 2022, JAXA Vice President Mr. Ishii and Head of the JAXA Paris Office, Mr. Sudo, and Mr. Ryota visited the ISU central campus in Strasbourg. The visit followed the signing of a new partnership between the two organizations signed in Paris by ISU's President Prof. P. Ehrenfreund – during the 73rd International Astronautical Congress in the presence of ISU Board of Chair, Dr. C. Sallaberger, and ISU North America VP Ken Davidian. This agreement strengthens the cooperation and aims at increasing synergies. The JAXA delegation met with representatives from the ISU Faculty, led by Prof. Peter and Prof. Tejumola, who presented his research on plasma instrumentation with the Kyushu Institute of Technology (Kyutech) that was born from the HORYU-IV satellite. Prof. Wotring presented the ISU research labs, especially the new in- house capabilities in Space Life Sciences Research.

Partnership between ISU and Euroconsult

At the occasion of the International Astronautical Congress (IAC) in Paris, the leading space organization Euroconsult and ISU entered into a partnership by signing a Memorandum of Understanding on 20th September 2022. In addition to the agreement with NSR Space, this strengthens the cooperation between ISU and space consulting companies in the areas of internships, lecturing, and information exchange.

Collaboration between ISU and Metavisionaries

Also during the International Astronautical Congress, the International Space University and the Metavisionaries signed a Memorandum of Understanding allowing a framework for collaboration on future courses such as the newly designed Executive Space Course on Medicines in Space that will take place in November 2023 at Oxford University in the UK.

Partnership between ISU and the Space Foundation

In April 2022, the Space Foundation, a non-profit advocate organization founded in 1983, signed a Memorandum of Understanding with ISU at the 37th Space Symposium in Colorado (USA). The new partnership will allow both organizations to coordinate space and space awareness education programs focused on expanding the diversity and entrepreneurial engagement of the global space ecosystem and, in particular, between the Space Foundation Space Commerce Institute and the ISU Space Policy and Entrepreneurship Lab (SPEL). In preparation for the 2024 Space Symposium, ISU is working with Space Foundation personnel to develop and execute the Space Commerce Executive Global Exchange, a seven-month program starting in the U.S. and ending in Europe. Between these two in-person meetings are five monthly virtual workshops featuring guest lecturers and activities addressing the primary concerns of the program participants.

Space Forum in Bahrain

On 10th November 2022, ISU Prof. Nicolas Peter attended the Space Forum of the 10th Bahrain International Airshow to moderate a panel on “How to engage new generations in space.” The session addressed diverse ways and means to engage the new space generation and, in particular, the roles of education, scientific research, public awareness, innovation, and industrial advancements in the new era.

New Space Economy in Rome

The ISU President, faculty, and staff participated together with a delegation of the ISU Incubator in the New Space Economy, Expoforum event in Rome in December 2022. ISU was part of the opening ceremony, several workshops, and the exhibition.

UN COPUOS Activities

The ISU President and many ISU alumni, led by Joe Pelton, attended the Panel on “Space Systems and Achievement of the UN Sustainable Development Goals for 2030” at the UN General Assembly Science Summit on 26 September 2022.

The ISU President also attended the 60th Session of the Scientific and Technical Subcommittee of UN COPOUS in February 2022 and gave a statement in the name of ISU about the University’s contributions to the goals of the UN, and the role of ISU in preparing the new generation for Space Sustainability. Prof. Ehrenfreund reiterated that the vibrant space sector needs a stellar workforce that supports international cooperation and responsible behavior in planning and executing space ventures.

International Space University speaker: ON 13th February 2023, Master of Space Studies MSS22 year B student, Stephania Turyk – presented – both in person and online - the recent Team Project Report “Starship: Impact on the Satcom industry” as a tangible example of successful international dialogue.

Space Symposium 2023, Colorado Springs

An ISU delegation including the ISU President, Vice President, Prof. Nicolas Peter, and ISU admission staff participated at the Space Symposium in April 17 - 20, 2023, in Colorado Springs, Colorado, USA. The ISU President moderated the “International Space Cooperation Luncheon” and participated in the “International Education Panel”. ISU’s booth, tended by ISU faculty members, staff, and alumni, was the meeting point for ISU alumni, future participants, prospective students to its programs, be it the Master of Space Studies, Master of Science in Space Studies, Space Studies Program, Southern Hemisphere Space Studies Program, or Executive Space Course.



Fig.47: Alumni and BOT members in front of the ISU booth

The ISU President participated in:

- “Women in Space” panel at the EU Space Week 2022, 3-7 October 2022, Prague, Czechia
- Space Café, 8 November 2022, in the framework of the Executive Space Course in Tel-Aviv, Israel
- “Connecting @ll Space People in a Challenging Geopolitical Environment“ panel at the IAF Spring Meeting, 28-30 March 2023, Paris, France
- “Carbon Footprint of Monitoring Climate Change from Space" panel at the Global Space Conference on Climate Change, 23-25 May 2023, Oslo, Norway

and gave keynote lectures at the:

- IPSPACE, International Symposium on the peaceful use of Space Technology-Health, 18 November 2022, Beijing, Keynote: “Women’s role in space”
- United Nations/China 2nd Global Partnership Workshop on Space Exploration and Innovation, 23 November 2022, Beijing
- Emerging Space 2023, 30 May-1 June 2023, Bratislava, Slovakia, Keynote: “Supporting Emerging Space Ecosystems”
- SPACETIDE 2023, 4th of July 2023, Tokyo, Japan, Keynote “Building a new workforce for the space economy”
- 9th China (International) Commercial Aerospace Forum, July 2023 Wuhan, China, Keynote: “Space is the frontier of technological innovation”
- Space Challenges 2023, Sofia, Bulgaria, August 2023 Keynote: “The evolving space sector – Highlights

13. ISU North America

ISU Appoints Ken Davidian as VP North American Operations

The International Space University's (ISU) Board of Trustees has appointed Dr. Ken Davidian as Vice President for its North American Operations. He has taken office on 1 September 2022 in succession of Mr. Gary Martin, in post since 2020.

This report covers the activities conducted by the ISU's Vice President of North American Operations (ISU VP-NAO), Dr. Ken Davidian, during the period of 1 September 2022 to 31 August 2023. During this time, Davidian worked toward the overriding goal of establishing a permanent ISU presence in North America (ISU-NA). Toward this end, Davidian initiated two primary activities: Creation of the Space Sector Crash Course (SSCC), very similar in many ways to the ISU Executive Space Courses, to generate operating revenue that permits self-funded ISU- NA operations, and Establishment of a continental network of partnerships with organizations that share ISU's values and visions, to serve as regional focal points for ISU community members to engage in activities. Details for each of these activities are given below:

Space Sector Crash Course (SSCC)

To generate income for operating services and expenses required to run the ISU-NA office, Davidian focused a majority of his time planning, developing, and executing a new five-day short course entitled Space Sector Crash Course (SSCC). The SSCC offers an intensive deep-dive into the global space sector using the "3-I" approach focusing on international, interdisciplinary, and intercultural education. The SSCC provides comprehensive interdisciplinary space training for current and future leaders within the space sector context. Details can be found on the SSCC website (na.isunet.edu/space-sector-crash-course).

Davidian designed the SSCC operating model based on the traditional framework of ISU's seven departments with slight updating of names, including Space Physical Sciences, Space Life Sciences, Space Engineering, Space Policy and Law, Space Business and Management, Satellite Applications, and Space Humanities. Lecturers in all seven departments are drawn from the network of ISU Global Faculty. Davidian created a business model that roughly breaks even (revenues equal expenses) with approximately 15 fully paid participants with a registration fee of 5,000 USD. Although expected expenses and surplus are highly dependent upon the SSCC location, a surplus level that can provide an adequate level of ISU-NA operating expenses is based on 30 fully paid participants.

The pilot SSCC event is scheduled for 12-17 November 2023 in Houston, Texas and if all goes well at that event, ISU-NA plans to conduct 4-6 SSCC events in the 2024 calendar year. Prior to the announcement date of the first SSCC on 20 July 2023, the primary effort went into designing the course, identifying the "starting line-up" of lecturers for each of the seven departments, and developing the initial flyers used to socialize the course with potential customers. Since public announcement of the first SSCC event, primary efforts were channeled into marketing with the development and roll-out of flyers, web pages (na.isunet.edu/space-sector-crash-course), and operationalizing the SSCC registration and e- payment pages. The initial registration response was encouraging but subsequent efforts at payment have presented challenges. In response, a 20% reduction in registration price was subsequently offered with the hopes of increasing the payments received.

Establishment of a North American Partnership Network

To begin developing a continental network around which ISU community members (including alumni, staff, faculty, lecturers, etc.) can meet for regional events and activities, Davidian approached universities and organizations with the offer to enter into informal partnerships as a basis of activities between the organizations and ISU community members to achieve a mutual goal of interest. These partnerships serve two purposes: as a potential meeting place for regional ISU community members to assemble for organized discussions and networking events (e.g., Space Cafés or Space Happy Hours, respectively), and as a potential venue for future SSCC events.

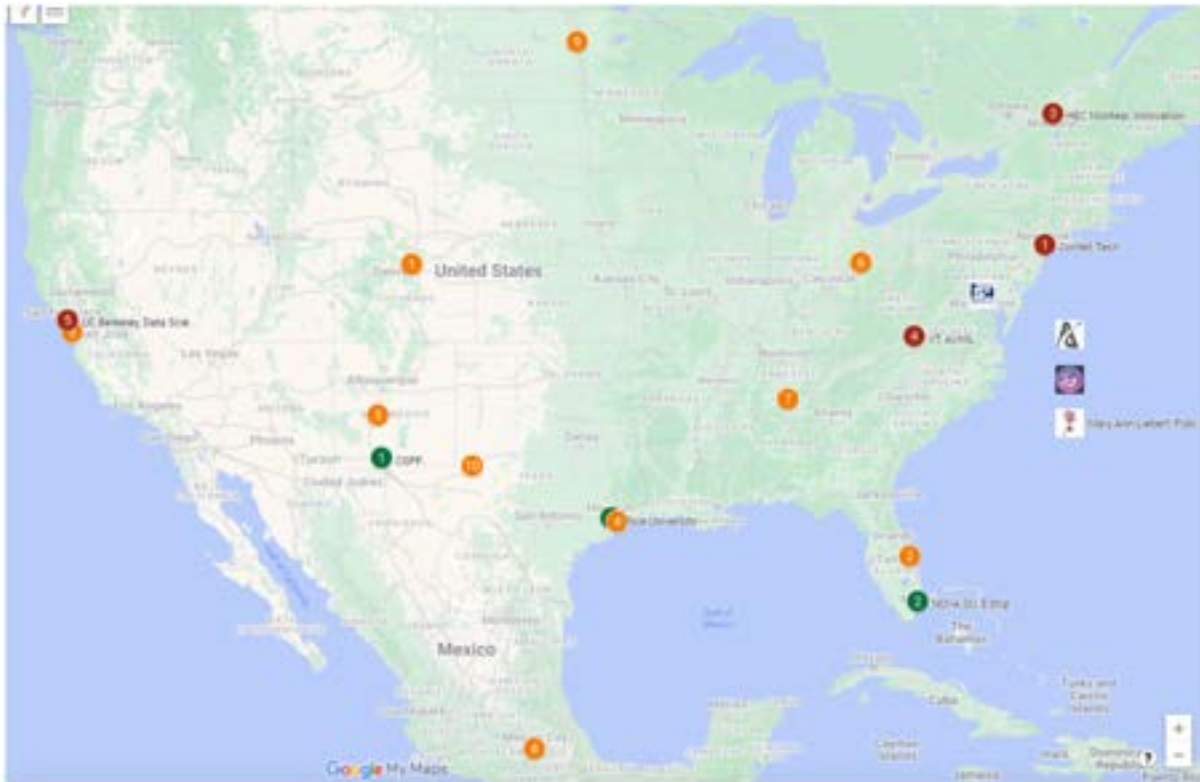


Fig.48: map showing the locations of organizations that are potential or current ISU partners

The map above shows the locations of organizations that are potential or current ISU partners based on this activity. The map shows the location of ISU-NA “headquarters” in Washington DC. At the time of this report writing, organizations who have executed an informal letter of partnership (identified with green circles) with ISU-NA include NOVA Southeastern University in Fort Lauderdale, Florida, and the Commercial Space Progress Foundation in Las Cruces, NM. ISU received a Letter of Intent from Rice University to host SSP24, so it is also represented as a partnering organization. Other partnering organizations shown include Mary Ann Liebert Publishers, the Global Spaceport Alliance, and Galactic Girl. ISU joined the Global Spaceport Alliance (GSA) to further develop the North American network and to take advantage of the marketing and conference visibility opportunities it provides. Paid membership in other industry organizations by ISU and/or ISU-NA is currently under consideration.

The orange circles represent organizations across North America approached by Davidian with the idea of partnership but who have not yet executed the proposed agreement. The red circles represent organizations who have yet to be approached to partner with ISU-NA. A table listing the organizations represented by the orange and red circles are given below. The map clearly shows that no solicitation of organizations in the Pacific Northwest region has yet been accomplished, although initial attempts at communication have been made.

Table 1. List of Solicited and Not-Yet-Solicited Partner Organizations

Solicited (Orange) Organizations	Not-Yet-Solicited (Red) Organizations
<ol style="list-style-type: none"> 1. Commercial Space Progress Foundation (CSPF) 2. University of Colorado (CU Boulder) 3. Florida Tech (Florida Tech) 4. NASA Ames Research Center (NASA ARC) 5. NASA Johnson Space Center (NASA JSC) 6. New Mexico Institute of Mining and Technology (NMT) 7. Ohio State University (OSU) 8. College of Business (UAH) 9. Universidad Nacional Autonoma de Mexico (UNAM) 10. University of North Dakota (UND) 11. CEED Building (UTPB) 	<ol style="list-style-type: none"> 1. Cornell Tech 2. HEC Montréal 3. McGill University 4. Virginia Tech (VT) 5. University of California, Berkeley (UC)

Subsequent to developing partnerships with these organizations is the activation of regional ISU community organizations. Davidian developed a draft Terms of Reference to guide and identify the minimum requirements of membership numbers and activities for these Regional ISU Community Chapters (RICCs). The purpose of each RICC is to to increase the visibility of ISU and ISU-NA in North America, and to encourage participation in ISU's many programs.

Additional ISU-NA Activities

The following activities and events took place within ISU-NA by the VP-NAO:

To assist with social media marketing activities and future SSCC logistics support, the ISU

- VP-NAO recruited the services of an unpaid intern, Mr. Rush Deeter. Mr. Deeter is a graduate of the Ohio University (site of SSP15) with a bachelor’s degree in physics and a Masters of Business Administration. Although Mr. Deeter’s services are currently unpaid, it is hoped that he will receive some level of retroactive compensation based on a successful SSCC event.
- Davidian traveled to Sao José dos Campos in November with the ISU SSP team to assist with
- negotiations between ISU and the lodging providers and SSP host organizations.
- In support of the SSCC or partnership activities, Davidian traveled to multiple cities to establish and strengthen relationships with different organizations, including Orlando, Florida (Astronaut Memorial Foundation, NOVA-SU), Denver, Colorado (CU Boulder, Advanced Space), Colorado Springs, Colorado (Space Symposium), San José, California (NASA Ames), Brownsville, Texas (potential SSCC site), and Houston, Texas (SSP24 and SSCC venue selection).

14. Conclusion

ISU has been very successful in obtaining the accreditation for its new Master's program and being awarded with several research grants from the European Commission and Foundations. For the second time, the SSP has been organized in South America and the academic year 2022/2023 saw also the revival of the in-person SHSSP (following the COVID pandemic) and many successful ESCs worldwide.

We hope you enjoyed reading this report. Please contact us if you want to engage with the International Space University in the future through participation in our education and research programs, mentorship, or sponsorship. We wish you a successful academic year 2023/2024 and remain at your disposal to discuss any space-related topic.



Annex 1: Faculty List

Click on the link below for a complete list of our esteemed faculty members: Central Campus Faculty Member, Faculty, Adjunct Faculty, and Associate Faculty. Discover the diverse expertise that fuels the success of our institution: [Link to ISU Faculty list](#).

Annex 2: Publications

Peer-reviewed publication

Baqué, M, Backhaus, T., Meeßen, J., Hanke F., Böttger, U., Ramkissoo, N., Olsson- Francis, K. , Baumgärtner, M., Billi, D., Cassaro, A., de la Torre Noetzel, R., Demets, R., Edwards, H., Ehrenfreund, P., Elsaesser, A., Foing, B. et al. Biosignature stability in space enables their use for life detection on Mars, *Science Advances*, *Science Advances* Vol 8, Issue 36, DOI: 10.1126/sciadv.abn7412, 2022.

Farhang, A.; Smoker, J.; Cox, N. L. J. ; Cami, J.; Linnartz, H.; van Loon, J.Th. ; Cordiner, M.A.; Sarre, P.J. ; Khosroshahi, H. G. ; Ehrenfreund, P.; Foing, B.H. ; Kaper, L.; Laverick, M.: The EDIBLES survey VI. Searching for time variations of interstellar absorption features, accepted in *Astronomy & Astrophysics*, August 2023.

Falduto, M. and Peeters, W., Trade-Off approach for launching Smallsats, *New Space* Vol. 11(2), April 2023. Pp. 71-81.

Gratiot, N, Klein, J, Challet, M., Dangles, O., Janicot, S., Candelas, M., Sarret, G., Panthou, G., Hingrayl, B., Champollion, N., Montillaud, J., Bellemain, P., Marc, O., Bationo, C.-S., Monnier, L., Laffont, L., Foujols, M.-A., Riffault, V., Tinel, L., Mignot, É., Philippon, N., Dezetterl, N., Caron, A., Piton, G., Verney-Carronl, A., Delaballe, A., Bardet, N., Nozay- Maurice, F., Loison, A.-S., Delbart, F., Anquetinl, S., Immell, F., Baehr, C., Malbetl, F., Berni, C., Delattre, L., Echevin, V., Petitdidier, É., Aumont, O., Michau, F., Bijon, N., Vidall, J.-Ph., Pinel, S., Biabiany, O., Grevesse, C., Mimeau, L., Biarnès, A., Re´ capet, Ch., Costes-Thiré, M., Poupaud, M., Barret, M., Bonnin, M., Mournetas, V., Tourancheau, B., Goldman, B., Bonnet, M. P., Michaud Soret, I.: A transition support system to build decarbonization scenarios in the academic community, *PLOS Sustainability and Transformation*, April 2023.

Peeters, W., *Cyberattacks on Satellites. An Underestimated Political Threat*. LSE IDEAS (LSE, 2022), available under <https://www.lse.ac.uk/ideas/projects/space-policy/publications/Cyberattacks-on-Satellites>

Roy, A., Surendra, V.S., Ambresh, M., Sahu, D., Meka, J.K., Ramachandran, R., Samarth, P., Pavithraa, S., Jayaram, V., Hill, H., Cami, J., Rajasekhar, B.N., Janardhan, P., Bhardwaj, A., Mason, N.J. and Sivaraman, B. (2022). Shock processing of amorphous carbon nanodust. *Advances in Space Research*, 70(8), 2571.

Sivaraman, B., Rahul, K.K., Ambresh, M., Sahu, D., Meka, J.K., Chou, S-L, Wu, Y.J., Gupta, D., Das, A., Lo, J-I, Cheng, B.M., Rajasekhar, B.N., Bhardwaj, A., Hill, H., Janardhan, P. and Mason N.J. (2023). N-graphene synthesized in astrochemical ices. *The European Physical Journal*, D 77 (2), 24.

Ignjatović Stupar, D., Ogrizović, V., Rošer, J., Poslončec-Petrić, V., Vižintin, G. Conceptual Navigation and Positioning Solution for the Upcoming Lunar Mining and Settlement Missions Based on the Earth’s Mining Experiences: Lunar Regional Navigation Transceiver System, *Minerals*. 13 (2023) 371. <https://doi.org/10.3390/min13030371>.

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Dimoska, M., Ignjatovic Stupar, D., Chabrol, G.: Setting up a lunar dust 3D solar printer in collaboration with ECAM Strasbourg improvements of the 3D solar printer and its capabilities in comparison with other additive manufacturing technologies, (2022), IAC-22,C2,5,8,x67723

Gulacsi, E., Ignjatovic Stupar, D., Cordero, R.: Protection against space radiation with the use of fungi - multipurpose use of mushrooms, (2022), IAC-22-A5,4-D2.8,6,x67709

Pouwels, C., McHenry, N., Chamitoff, G., Tejumola, T., Gomez, I., Artiles, A. D. Applications of Augmented Reality for Extravehicular Activity: Field Results from the implementation of SCOUT Assistant on EVA Spacesuits” (2022). IAC-22,B2,IPB,10,x73468

George, L., Loffler, T., Tejumola, T., Klinkner, S., Knoll, A. Intra-Orbit In-Situ Plasma Measurement Using Cost-Effective Research And Observation In Medium Earth Orbit (Romeo) Micro-satellite Platform, (2022). IAC-22,B4,2,6,x70978

Peter, N. and Robinson, D. Procurement a key driver to foster new markets in the new space economy (2022). IAC-22,E6,1,10x69617

Richardson, C., Peter, N. The Global Space Accelerator Landscape (2022). IAC-22,E6,3,4x73723

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Murphy, J., Peter, N. What's New in NewSpace: Mapping and Defining NewSpace (2022). IAC-22,E3,2,10,x70136

Pantaleon, D., Peter, N. NewSpace and Space Exploration: A Comparison Between the USA and Europe Approach to Procurement (2022). IAC-22,E3,2,7,x69278

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Ahwah, J., Bouchalat, S.M., Dimoska, M., Gulacsi, E., Gutierrez, J., Holle, M., Hwang, Y., Konstantopoulou, A., Lespagnol, J., Murphy, J., Nzeussi Mbouendeu, C., O'Sullivan, Damini Pantaleon, Swapnil Parekh, Niravkumar Patel, Laura Perez Tembleque, Marion Pigassou, T., Talbi, K., Turyk, S., Tejumola, T., Peter, N., Sun, G. Starship Impact on the SatCom Industry (2022). IAC-22,B2,IPB,10,x73468

Articles/Memos

IDN Brief (Portuguese National Defense Institute)

N. Peter "The Space debris challenge to the sustainability of the space economy"

<https://www.idn.gov.pt/pt/publicacoes/idnbrief/Paginas/IDN-Brief-21-outubro-2022.aspx>
DGAP Memo

Peter, N. "What If European Space Systems Stopped Functioning For a Day?"

<https://dgap.org/en/research/publications/what-if-european-space-systems-stopped-functioning-day>

Outreach

SpaceWatch GL Opinions:

The Cassini Hackaton at ISU and its Role in the Entrepreneurial Space Ecosystem:

<https://spacewatch.global/2022/11/spacewatchgl-opinion-the-cassini-hackathon-at-isu-and-its-role-in-the-entrepreneurial-space-ecosystem/>

International Space University to Organize 4th Cassini Hackaton:

<https://spacewatch.global/2022/10/international-space-university-to-organize-4th-cassini-hackathon/>

Annex 3: Useful Links

[ISU WEBSITE](#)

[ISU LIBRARY](#)

[STUDENTS PROJECTS](#)

[JOB CENTER](#)

[PHOTO GALLERY](#)

[ISU TWITTER ACCOUNT](#)

[ISU FACEBOOK PAGE](#)

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[ISU YOUTUBE CHANNEL](#)